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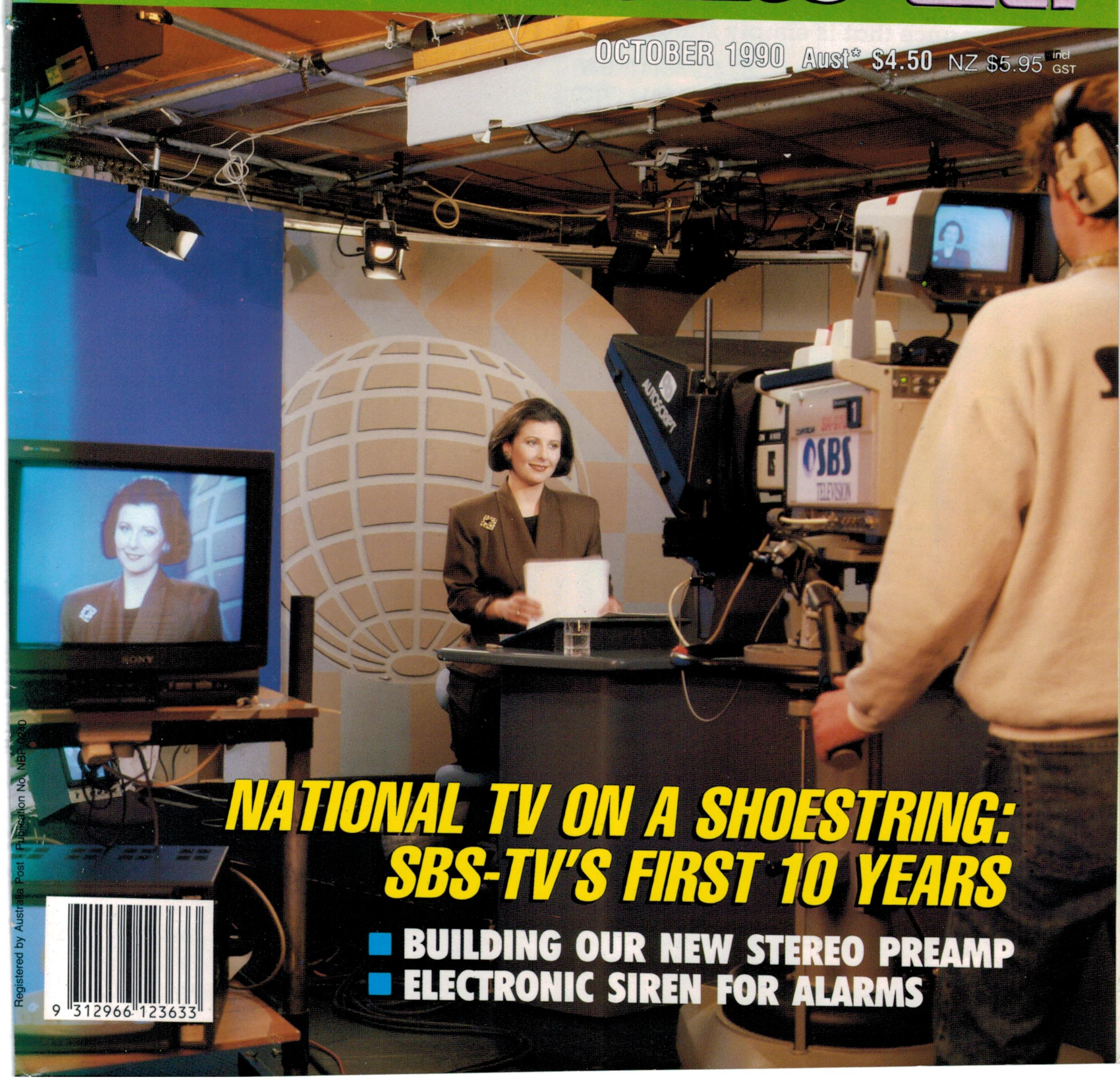

OCTOBER 1990 Aust* $4.50 NZ $5.95 incl GST

NATIONAL TV ON A SHOESTRING: SBS-TV'S FIRST 10 YEARS

- BUILDING OUR NEW STEREO PREAMP
- ELECTRONIC SIREN FOR ALARMS

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Volume 52, No.10

Electronics Australia

October 1990

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Win an Icom IC-R100 receiver!

Icom's new 'mighty midget' IC-R100 communications receiver is an eavesdropper's dream, tuning from 100kHz all the way up to 1856MHz (see page 54). And you can win one of these little beauties for yourself – see p.59.

Workstation

You'll find this month's Workstation towards the end of the magazine, starting on page 145. Among the features is a review of Sharp's new JX-100 compact 200dpi colour scanner, for use in desktop publishing, etc.

eti

This month's ETI starts opposite page 74. It includes an 'extra supply rail' converter, and part 11 of Jack Middlehurst's 'Building Blocks' series.

On the cover

Presenter Mary Kostakidis shown at work in SBS-TV's somewhat cramped main studio, in Sydney. SBS Television is having its 10th Anniversary this month – see our story starting on page 28. (Picture courtesy SBS-TV)

Entertainment Electronics

Features

Projects and Technical

Workstation

News and Comment

Departments

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LETTERS TO THE EDITOR

Illumination unit

Your correspondent Peter Phillips (page 45, May 90 issue) may be interested to know that the 'Carcel' referred to in his old book was in fact, the French standard of illumination, equal to 9.62 Int.candles. He is wise to suspect the figures he quotes, as when recalculated they give an efficiency of about six milliwatts for one candle power. This is out by a factor of about 500 for the carbon filament lamps of the time.

As a new subscriber to you magazine, I have been particularly interested in your historical articles. Pity that my April issue had pages 19-34 and 99-114 missing. Can you help me please?

P. Steel,
Jarrahdale, WA.

Comment: We've sent you a replacement copy, Mr. Steel. Thanks for your information, and we're glad you like the historical features.

Scarting about

In *EA's* very thorough review of Philip's new Matchline digital vision TV (May 1990), you have revealed the wide array of interconnection sockets – including Scart – built into this deluxe product.

As your reviewer has questioned the availability of adaptor cables for Scart connection, I am pleased to advise that Philips makes available a range of six audio and video Scart leads.

Most Dick Smith stores carry stocks of these, or they can be ordered in. Other stores like David Jones, Retravision and Chandler stores also stock or will order. Of course, all Philips service counters offer cash sales on Philips' vast range of connection cables.

Any *EA* reader wanting advice on locating an appropriate interconnection lead can call (02) 742 8425.

Your reviewer also noted that this latest Matchline digital TV is, through its Scart wiring, D2bus-prepared. With a number of major Japanese manufacturers adopting this Philips D2B interconnection control system, your readers can soon expect to see an increase in the number of consumer electronics products designed with Scart connections. It is certainly a very simple one plug error-free interface, with agreed standards prescribed for a host of new applications like D2B, priority links and scrambling/encryption hook-ups.

James France,
Marketing Manager,
Philips Accessories,
Homebush, NSW.

Upset amateur

I'm sure that I am only one of thousands of amateur radio operators who took exception to the comments by Mr Paul Wraith (VK4ZWD), in 'Letters to the Editor' *EA*, May 1990. His old fashioned idea that 'ham radio operators who use commercial gear are merely glorified CB'ers...' is particularly narrow-minded.

It really is an insult to those operators whose interests in radio are more diversified than simply building their own equipment. Don't get me wrong, 'homebrewing' your own gear is an admirable radio covers a wide spectrum (pardon the pun) of activities. In most of these, radio equipment of a high technical standard is a distinct advantage.

Depending on individual skills and interests, each of us tend to concentrate on a particular branch of amateur radio, whether it be antenna design, computers, satellite communications, repeaters, simple chats with friends, and yes, even building your own equipment. If an operator chooses not to participate in any of these activities, it is entirely up to them. It certainly does not brand him or her as being inferior in any way.

Hopefully, people with opinions like Mr Wraith are in the minority because it is the combination of all diverse aspects of amateur radio which make it great.

C.W (Ted) Krapkat, VK4NXO,
Mt Larcom, Qld.

Leak amplifiers

I read with much interest the article in your July 1990 issue titled 'The Williamson Amplifier', which provides an excellent overview of the characteristics of this amplifier. The Williamson ampli-

fier was undoubtedly at the 'leading edge' of amplifier technology in 1947, and as the circuit was published in the technical press, many audio enthusiasts could afford to build a superlative amplifier using quality transformers (produced by a number of manufacturers). These factors lead to the unprecedented popularity of the design.

I would like to have seen the article also cover the pioneering work achieved by Harold Leak. Leak started out working in the cinema industry with Gaumont Cinemas in England. In 1934 he started his own business – H.J. Leak & Co Ltd – and worked initially as a subcontractor building amplifiers for other firms. In 1945 Leak released the first amplifier in the famous 'Point One' series, so named as the total harmonic distortion at rated output measured 0.1%. The announcement of this astonishing performance first appeared in an advertisement in the *Journal of the British IRE*, September 1945. The earliest copy of such an announcement that I have been able to locate appeared in *Wireless World* in February 1946.

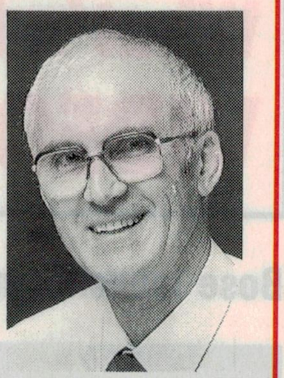
This level of performance was achieved through the use of considerable amounts of properly applied negative feedback, coupled with a triode connected output stage (as it was in the Williamson amplifier two years later). In the case of the origina Leak 'TL/12' model, 25dB of feedback was applied over the three stages of the amplifier and the output transformer. High load damping factors were achieved, together with frequency response level within 0.25dB over the 20Hz to 20kHz. Furthermore Leak published gain and phase margins for the feedback loop (10dB and 20° respectively).

The Leak TL/12 amplifier set such improved standards in technical performance and physical layout and construction of its components that it easily became the 'reference amplifier' in the sound and broadcasting industry. Leak went on to become one of the dominant names in the audio industry during the 1950's and 60's, and was one of the first British manufacturers to successfully export to the USA.

Harold Leak died in August 1989 at his home in Jersey. An obituary for him appeared in the *Journal of the Audio Engineering Society*, October 1989. His death failed to gain much attention elsewhere, and these early achievements appear to be fading into obscurity – something which prompted me to write this short reminder.

Stephen Spicer,
Glen Waverley, Vic.

EDITORIAL VIEWPOINT



Privatising Telecom, OTC: ideology reigns supreme

For the last few months I've been resisting the temptation to comment further about the ongoing Telecom/OTC/Aussat deregulation/privatisation debate. After all, as various readers have pointed out, these matters are basically political – and therefore well outside *my* limited expertise. But recent comments by both politicians and media experts have finally overcome my resistance. Even though it will almost certainly bring further wrath upon me, here goes:

I guess what irritates and worries me most about this debate is the way so many of the protagonists appear to base their position so heavily on ideology, rather than any kind of rational consideration and balancing of evidence. As a result, instead of sensible debate and discussion, what we seem to get so much of the time is a kind of verbal jousting: a contest to see whose ideology is strong enough to knock the other side over, and win the day.

As a result, the 'debate' seems to be boiling down to a choice between either (a) rolling Telecom and OTC together into a public-owned 'Megacom A', with Aussat flogged off to a new privately owned and competing 'Megacom B', or (b) flogging *everything* off to private organisations. And in either case foreign organisations seem likely to end up with major slices of the action, simply because we'll need their money.

What kind of alternatives are these? We're talking here about Australia's telecommunications systems – one of our most vital national resources. And yet in the name of supposedly greater 'competition' and 'efficiency' (not to mention that flavour of the decade 'deregulation'), both sides seem to be hell-bent on either rearranging them, or dismembering them and flogging bits off to the highest bidders.

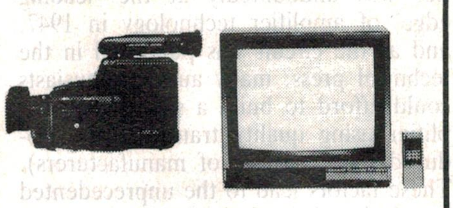
We wouldn't dream of doing this with our electric power authorities, or our water and sewerage utilities. Surely our telecommunications systems are no less important!

The crazy thing is that overseas, they're already starting to realise that *especially* in telecommunications, this blind drive towards deregulation and competition has probably resulted in the biggest disaster of this century: poorer service, higher costs and many more hassles, for most users. It seems incredible that Australia's decision makers want *us* to follow suit, and for what seems to be purely ideological reasons.

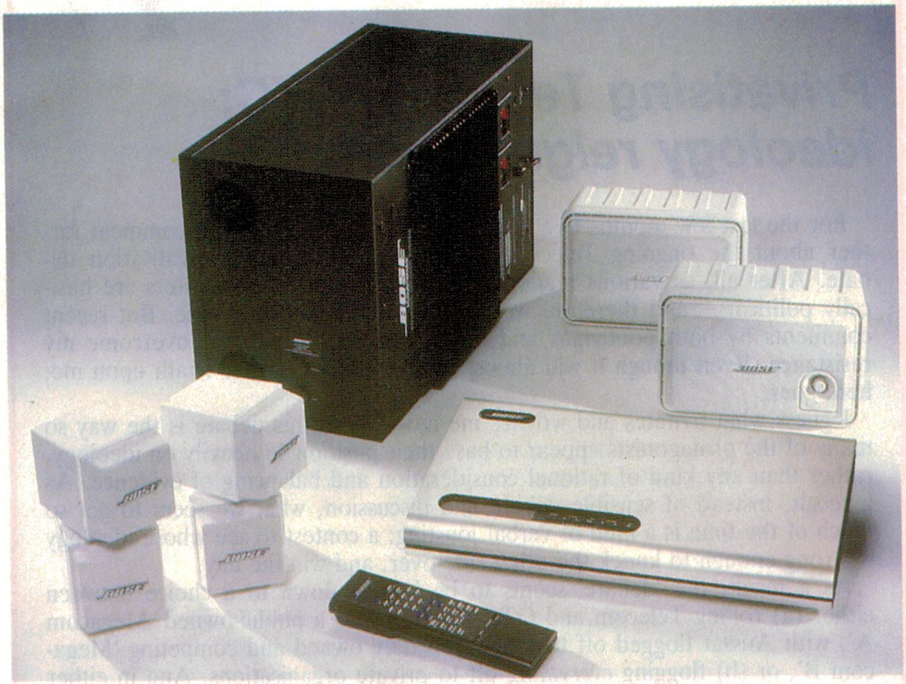
Jack Keavney's excellent book *The Time For Truth* looks objectively at what has in fact happened overseas with deregulation. From this, it's clear that despite their faults, Telecom Australia and OTC already compare more than favourably with their overseas equivalents. Surely any decision to tinker with them should only be made after *very* careful and objective consideration of the risks involved.

Jim Rowe

What's New in VIDEO and AUDIO



Bose launches new 'invisible' music system for the home



Bose Lifestyle System components. The bass driver/power amp unit is at upper left.

Recognising trends in favour of compact, unobtrusive music systems for the home, Bose Corporation has combined many of its previous innovations to develop a new 'Lifestyle' Music System, where many of the key components are virtually invisible. As the same time the new system provides a significant enhancement in terms of operational flexibility.

At the functional heart of the system is the Lifestyle Music Centre, which combines an AM/FM tuner, a CD player and a microprocessor-controlled preamp/line amp system. A slim and elegant looking tabletop unit, it is roughly the size of a telephone book: 420 x 244 x 62mm.

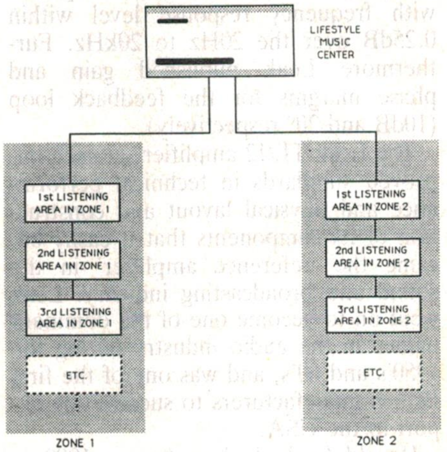
To allow the LMC to have such a compact size, the power amplifiers have been moved out – and incorporated within the loudspeaker system. In fact they're built into a compact bass driver unit, designed to be positioned out of sight, which uses Bose's well-known 'Acoustimass' double enclosure system for extended bass response.

The Lifestyle System's Powered Acoustimass unit itself measures only 464 x 321 x 250mm, and includes a 100-watt amp to drive its internal pair of 152mm bass drivers, plus a pair of 50W amps to drive the matching pair of compact 'twin cube' midrange/treble enclosures. These in turn measure only 187 x 117 x 92mm, and each feature a pair of 64mm wide-range drivers in magnetically shielded, adjustable cube enclosures designed to be mounted unobtrusively on a wall – or possibly behind light curtains.

An important advantage of the Lifestyle System's 'powered loudspeaker system' approach is that a single LMC can feed signals to multiple speaker systems, distributed both inside and outside the home. In fact the LMC is deliberately designed to allow independant supply and control of two different stereo signals at the same time – from say the CD player and FM tuner, feeding them to loudspeaker systems in different rooms.

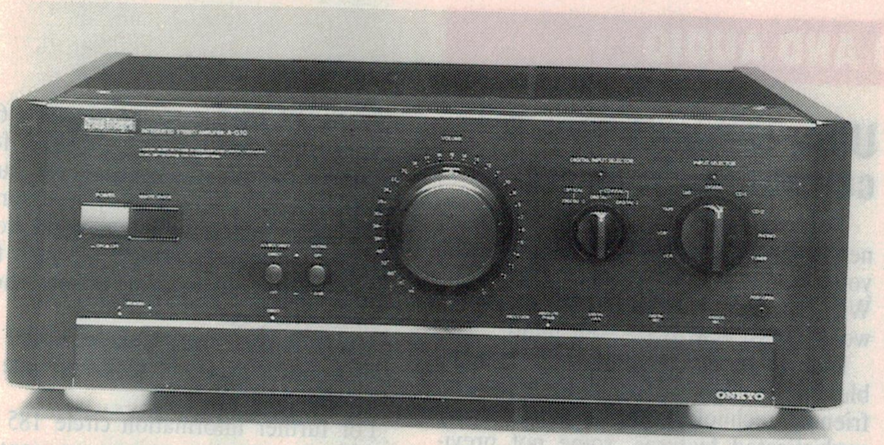
In normal operation, all main functions of the LMC are controlled via a multi-function handheld remote control, which can be switched to control either signal channel as desired. And in order to allow use of the remote in virtually any room, it uses a radio link rather than the common infra-red light. Operation is crystal controlled for stability, at 27MHz.

Other features of the Lifestyle System include active electronic equalisation, a Bose-patented 'Dynamic Equalisation' circuit giving optimum tonal balancing at any level of volume, and easy compatibility with external audio sources such as TV receivers and VCRs. Additional compact 'powered remote' loudspeakers are available for use with the system, as are additional remote controls.



The Lifestyle Music Centre provides two independently controlled stereo output channels, which can be piped to powered loudspeaker systems in various rooms or 'zones'.

For further information circle 181 on the reader service coupon, or contact Bose Australia, 11 Muriel Avenue, Rydalmere 2115; phone (02) 684 1022.



Integrated high-end amp from Onkyo

The new A-G10 is part of Onkyo's 'Grand Integra Series', the flagship of the Onkyo audio product line up. Using Onkyo's latest 'digital' technology, the A-G10 can accept source material in either normal analog or digital format, from CD (44.1kHz), DAT (48kHz), or future satellite broadcast (32kHz), either via optical fibre or coaxial cable input.

Onkyo employs its proprietary 'acculinear' 18-bit ladder network D/A converters which they claim have been 'tuned' at the factory as far as the fourth most significant bit. The benefit of such painstaking 'fine tuning' methods is crucial particularly when listening to very soft musical passages, where the non-linearity in conventional D/A converters can manifest itself as distortion.

Boosting 135 watts RMS per channel into 8 ohms and dynamic peaks of up to 460 watts (2 ohms), the A-G10 is designed to drive even the most inefficient of todays' speakers. Rated distortion is quoted at 0.008% at rated output, and frequency response from 2Hz to 50kHz within 1dB.

The A-G10 has provision for both MC and MM cartridges with ample sensitivity to match very low output (high end) moving coil cartridges on the market today (110uV). Equally important is the very high signal to noise ratio of the phono section, one of the highest in the industry at 85dB (reference 500uV MC). In addition to accepting both MC and MM cartridges the A-G10 has provision for; 2 x CD inputs, tuner, video disc, DAT, VCR, and processor (reverb or surround sound) plus separate pre-in and power-out facilities.

For further information circle 184 on the reader service coupon or contact Audio Insight, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 3011.

Monitor-style 34cm CTV from Akai

Akai's CTK-145 is a 34cm (14") monitor style colour TV with 16 button infra remote control.

Designed for both UHF and VHF transmissions, the CTK-145 will store up to 30 pre-set channels. It also employs Akai's FST (flatter square tube) technology which offers a larger, more linear image with less curvature of the screen. Combined with this is Akai's dark tint tube technology which enhances picture quality, particularly in situations where there are high ambient light levels.

The CTK-145 is covered by a three year national warranty on parts and labour. It has a recommended retail price of $469 and is available at Akai dealers and selected department stores.

For further information circle 187 on reader service coupon or contact Akai, 2 Australia Avenue, Homebush Bay 2011; phone (02) 763 6300.

High-quality two-way speakers

As with the other systems designed and manufactured by Orpheus Loudspeakers in Lilyfield, Sydney, the 'Dolomite' system is individually hand assembled and tested by designer Brad Serhan to ensure the highest level of quality control. The components and materials used are also of uncompromising high quality, allowing the firm to offer a 5-year guarantee.

The Dolomite system features two very solid, heavily braced and damped 38L enclosures measuring 611 x 325 x 290mm, and each weighing 18kg. The enclosures are made from 19mm high density customwood, braced and damped with 10mm tar pads.

Within each enclosure is a 200mm polypropylene cone bass/midrange driver in a QB3 bass reflex system, coupled with a 25mm metal dome polyamide-surround tweeter. High quality heavy gauge air-cored inductors and metallised polypropylene capacitors are used in the crossovers, to give very smooth and clean reproduction from 38Hz – 20kHz +/–3dB. Impedance is 8 ohms nominal, sensitivity is 90dB/1W/1m and power handling capacity is rated at 30 – 150W.

Recommended stands are the Audio Furniture 400mm model, as shown.

For further information circle 182 on the reader service coupon, or contact Orpheus Loudspeakers, 7 Ainsworth Street, Lilyfield 2040; phone (02) 569 9352.

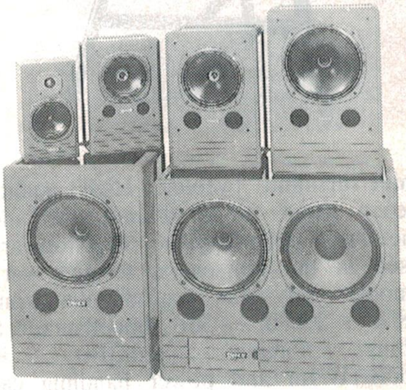
New Tannoy monitor speakers

Tannoy has released a new range of Monitor Series professional studio monitors, based on the firm's research in differential material technology (DMT) – the study of different materials and their relative behaviour when in intimate contact.

The new Monitor Series comprises six models, ranging from the System 215 DMT dual 15" professional monitoring system through to the compact System 2 NFM near-field monitor.

All cabinets are constructed from a high density MDF space-frame with rounded corners and edges to reduce sound reflections and diffractions from cabinet boundaries. DMT is applied to the cabinet design to effectively transmit or absorb energy in a frequency selective manner.

Five new mid/bass drivers are used in the Monitor Services, all featuring DMT in the suspension and termination of cones to chassis frames. New high frequency drivers complement the mid/bass drivers and feature computer designed waveguides to match the acoustic source impedance at the HF diaphragm into the listening environment. A new design voice coil assembly consists of a high temperature polyamide insulated, copper clad aluminium rectangular ribber conductor chemically bonded onto a glass-fibre former which fits onto the outside of the HF diaphragm skirt. Crossovers are constructed of very high



grade air cored inductors and film capacitors, and are all hard wired without the use of printed circuit boards.

For further information circle 186 on reader service coupon or contact Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211.

Ultra compact VHS-C camcorder from JVC

The only worry with slipping JVC's new GR-AX7 VHS-C Videomovie into your bag is forgetting that it's there. With a mass of around 750 grams, it won't weigh heavily on your mind!

Despite its size, the GR-AX7 is notable for its high performance and user-friendly technology which allows many sophisticated features, some not previously available on compact Videomovie cameras.

The chassis is 30% smaller than a conventional VHS-C video camera, and in fact fits in the palm of your hand.

For convenience and flexible shooting, the GR-AX7 is equipped with a 6:1 power zoom and JVC's advanced full range AF autofocus system with auto macro. High picture quality is assured by variable shutter speeds ranging from 1/50 for normal shooting to 1/4000 for clear, sharp, high-speed action shots with no blurring.

The GR-AX7 has been released in Japan and is expected to be on sale in Australia later this year.

For further information circle 185 on the reader service coupon or contact JVC, 13 Garema Circuit, Kingsgrove 2208; phone (02) 750 4188.

New three head tape deck from Marantz

Marantz Australia has released a new 'flagship' audiophile cassette deck, the model SD60, crammed with high-tech features.

The SD60 is a true three-head deck, allowing off-tape monitoring for instant comparison of a recording with source material. Three-head design has also allowed provision of optimum head gaps for recording and playback; two-head machines must compromise with dual-purpose tape heads.

A special cassette stabiliser ensures the cassette shell cannot pick up and amplify mechanical vibration from the tape transport system – a common source of distortion in many cassette decks.

A new design direct-coupled tape-head amplifier, specially developed by Marantz engineers using delicate phone-stage technology, is claimed to deliver remarkable dynamics and fine musical detail.

The SD60 has both Dolby B and C noise reduction to fully exploit the performance of modern tape formulations. It also has the Dolby 'HX-Pro' headroom extension systen, which automatically ensures the best possible high-frequency response and lowers distortion during the recording process. Tapes made with this system can be enjoyed to the full on any cassette player, even if it does not have HP-Pro.

The SD60 will sell for a recommended $899. Like all Marantz equipment, it carries a two-year warranty.

For further information circle 188 on reader service coupon or phone Marantz Australia's hotline on (008) 22 6861.

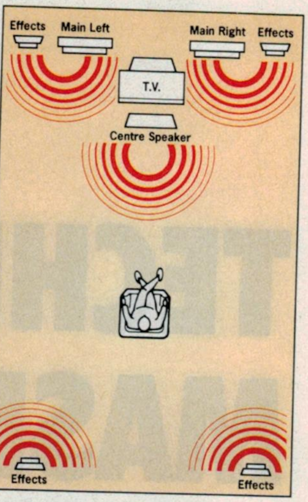
Yamaha brings you the most innovative entertainment technology since moving pictures...

Moving sound.

Prepare yourself for a very special audio and video experience.

With Yamaha's innovative Digital Sound Field Processor technology, you can recreate the excitement of actual live performance venues and cinema sound, right in your own living room.

Digital Sound Field Processing precisely recreates the special ambiance of these environments, for a breathtaking listening experience.



Multi-dimensional sound imaging created with a 7-speaker DSP-Dolby Pro Logic surround system.

At the touch of a button you can have the acoustic characteristics of a European concert hall, a Jazz club, an open air Rock venue, a Disco, a Church or even an Opera house.

Yamaha's exciting 'Moving Sound' system: The DSP-A700 amplifier and it's companion AVS-700 selector, centre speaker, main speakers and the smaller effects speakers.

When watching video, just select DOLBY* PRO-LOGIC SURROUND to recreate the magic of the cinema.

For example, when a movie shows a gun being fired, you'll hear the bullet ricochet around the room. When a plane prepares to land, you'll hear it soar over you from behind and touchdown at the front of the room - that's just how life-like this system sounds! All functions are fully managed by a learning remote control which completely integrates and operates your TV, video and audio system.

To experience the excitement of 'MOVING SOUND' and to find out just how easy this system is to operate and install in your living room, see your local YAMAHA HI-FI Specialist now.

YAMAHA
FIVE YEAR WARRANTY

*Dolby Pro Logic Surround is a trademark of Dolby Laboratories

READER INFO No. 2

The Challis Report:

TECHNICS' SL-PS70 MASHES ITS RIVALS

The new 'one-bit' CD players are coming out thick and fast now, and Louis Challis has just put the new Technics mid-range SL-PS70 'MASH technology' model through its paces. He found it very impressive – not only in terms of performance and facilities it provides, but also because of the amount of fresh air he found inside the case!

Over the last eight years, Technics has designed many excellent mid-priced CD players – the majority of which have displayed considerable ingenuity and quite a few offered innovative features which the market place and their competitors have rapidly adopted.

The first Technics CD player which I reviewed was the SL-P8, and as I recall, that particular CD player proved to be a 'hard act to follow' as it incorporated a remote volume control as well as other desirable features.

Having recently reviewed the first of the Philips 'one bit' machines (their CD840), I was not really surprised to see that Technics had also released their version of the 'one bit' technology. Being well aware of the innovative flair of the design engineers at Matsushita's research laboratories, I was well prepared for what I found in the SL-PS70. But at the same time this particular CD player has so few similarities to the Philips machine, that one could genuinely ask "Do they really have anything in common?"

The SL-PS70 is in fact something of an enigma. It is extremely light (who was it who said that CD players must use

materials like reinforced concrete or an artificial stone for the chassis!) One's first impressions of its external visual characteristics tend to belie the power and potential of this 'third generation' CD player.

With the player I received a photocopy of Technics' *1990 Compact Disc Player Sales Manual* which stated in the most positive terms that this unit is a 'third generation – one bit' player. Now wait on a second! It was only around the first week in January of this year that I saw my first 'one bit' player in Las Vegas! What in the world happened to the '1st Generation one bit players', and for that matter, the '2nd Generation one bit players' as well?

Could it be that this simple statement was a mistranslation of the Japanese, which may have stated in much simpler terms that "this 'one bit' player is a 'third generation' machine" and the marketing people turned a blind eye to the misplacement of the emphasis, so that the intending buyer would believe that they are about to purchase a markedly superior product? We may never really know the answer, for although I made contact with a number of my friends at National Panasonic's Sydney office, no one was able to give me a straightforward answer.

But rather than confuse you with what is in essence a secondary issue, it's better that I should describe the list of positive, most desirable attributes and features with which this particular CD player abounds.

The last Technics CD player I reviewed was the SL-P770 (see *ETI* February 1989), which incorporated an 'edit control' feature through which the user could calculate the number of tracks which could be recorded on two sides of a compact cassette. I considered that to be a somewhat revoluntionary feature, whose practical advantages impressed me greatly. I was delighted to find that the SL-PS70 had taken that feature and refined it, to the point where it offers the user even more advantages and would appear to be a markedly superior concept.

The Synchro Edit control is a feature that puts this CD player at the 'top of the class' in terms of its user friendly features. This is further enhanced by the Automatic Peak Level search function, which when combined with Synchro Edit, provides an unbeatable combination in terms of practical home recording functions.

As you quickly find by activating the automatic peak level search button, the CD player searches through the disc at what is described as being a 'relatively high speed' and finds the location of the highest transient signal on the disc –

MEASURED PERFORMANCE OF TECHNICS SL-PS70

SERIAL NO. 1314

1. Frequency Response

20Hz to 20kHz	+/–0.2dB
5Hz to 22.05kHz	+/–0.2dB

2. Linearity

Nominal Level	L.Channel Output	R.Channel Output
0dB	0.0	0.0
– 1.0	– 1.0	– 1.0
– 3.0	– 3.0	– 3.0
– 6.0	– 6.0	– 6.0
–10.0	–10.0	–10.0
–20.0	–20.0	–20.0
–30.0	–30.0	–30.0
–40.0	–40.0	–40.0
–50.0	–50.0	–50.0
–60.0	–59.9	–60.0
–70.0	–70.0	–70.0
–80.0	–80.1	–80.1
–90.0	–89.4	–89.4

3. Channel Separation

Frequency	Right into Left dB	Left into Right dB
100Hz	116	120
1kHz	111	113
10kHz	95.0	89.5
20kHz	82.0	78.0

4. Distortion

	Level	2nd	3rd	4th	5th	THD%
(@ 1kHz)	0	109.7	100.6	116.7	115.7	0.0021
	– 1.0	109.6	100.5	116.0	-	0.0021
	– 3.0	111.7	103.5	-	-	0.0015
	– 6.0	112.8	109.3	-	-	0.00094
	–10	111.2	109.7	-	-	0.001
	–20	-	91.5	-	-	0.0051
	–30	-	90.2	-	-	0.0059
	–40	-	-	-	-	-
	–50	-	70.3	-	71.2	0.07
	–60	-	58.2	63.5	59.2	0.28
	–70	-	48.6	-	45.4	1.03
	–80	-	37.0	-	33.6	4.0
	–90	-	-	-	17.0	19.7
(@ 100Hz)	0	-	101.1	-	108.7	0.0017
	–20	111.3	110.1	108.1	105.3	0.0014
	–40	91.7	-	-	-	0.0077
	–60	70.7	67.6	-	65.6	0.14
(@6.3kHz)	0	97.7	101.9	-	-	0.0041

5. Emphasis

Frequency	Recorded Level	Output Level (L)	Output Level (R)
1kHz	–0.37dB	–0.4	–0.4
5kHz	–4.53dB	–4.6	–4.6
16kHz	–9.04dB	–9.7	–9.5

6. Signal to Noise Ratio

Without emphasis	104dB (Lin)	111dB (A)
With emphasis	105.5dB (Lin)	113dB (A)

7. Frequency Accuracy (19.999kHz) –2Hz for 20kHz test signal

8. Square Wave Response See attached photos

9. Impulse Test See attached photos

10. Dirty Record Test

Interruption in Information Layer	400 micrometre:	Passed
	500 micrometre:	Passed
	600 micrometre:	Passed
	700 micrometre:	Passed
	800 micrometre:	Passed
	900 micrometre:	Passed
Black Dot at Read out Side	300 micrometre:	Passed
	500 micrometre:	Passed
	600 micrometre:	Passed
	800 micrometre:	Passed
Black Stripe Test	Test Disc No.1 or 2:	Passed
Output Impedance	Headphone Amplifier:	100 ohms

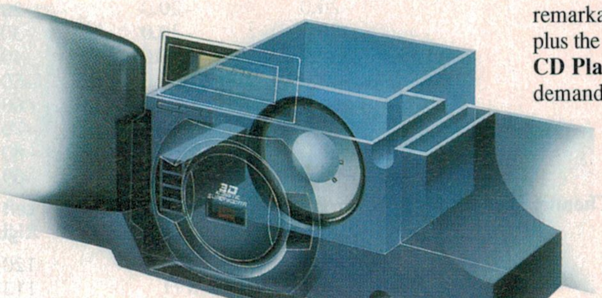
The New 1990 Model

Hitachi breaks the sound barrier- Acoustic Super Woofer in a portable unit.

Hitachi CX-W700W offers sound quality equal to that of many mini-component systems in a portable unit. You get a remarkable 200W (PMPO) audio output with powerful, solid bass, plus the full benefit of CD digital sound.

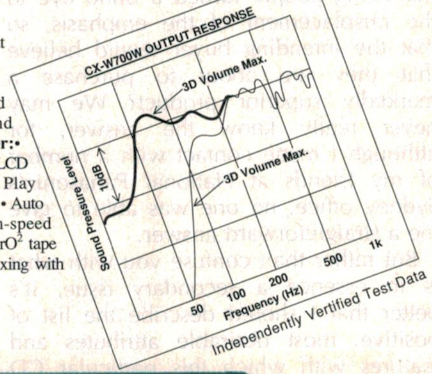
CD Player: The optimum quality of digitally recorded sound demands a high level of performance from the amplifier and speakers. Hitachi CX-W700W delivers the wide frequency response needed to get the most out of CD recordings.

Home Music System: Hitachi CX-W700W is equipped with radio, twin cassette decks and a CD player. So whatever your choice in listening pleasure, this single compact unit will meet your needs.



New Acoustic Super Woofer System
Equipped with its own 3D amplifier, this new system meets the performance standards needed for high-quality digital sound. And by sealing the super woofer in a rear chamber, reverse phase frequencies are prevented from interfering with low-frequency output ensuring clear, rich bass.

• 200W (PMPO) audio output • New 3D Acoustic Super Woofer system • Two full-range12cm speakers • Surround sound system • Three-band graphic equalizer **CD Player:** • 32- program random memory • LCD track number display • CD Play /Rec.Synchro **Cassette Decks:** • Auto Reverse (on Tape 1) • High-speed dubbing • AutoStop & Nor/CrO^2 tape selector (on Tape 2) • Mic mixing with volume control.



3D BASS
ACOUSTIC SUPER WOOFER

COMPACT disc DIGITAL AUDIO

CX-W700W
Portable 4 Band Radio/Stereo Double CassetteRecorder/
CD Player with 3D Super Woofer

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READER INFO No. 3

which it logs automatically. It then cycles repeatedly through that particular five second sequence, while you set the recording controls of your cassette player or conventional reel to reel recorder. Nothing could be easier.

After setting the volume controls, you can revert to the play mode and then rest assured that you will not 'over modulate' the subsequent recording. It ensures that a novice can achieve perfect tape recordings almost irrespective of the type of cassette player being used, and virtually removes the possibility of tape saturation, over modulation or even partially recorded tapes.

The third important feature on the SL-PS70 is the Automatic Edit function. This feature automatically calculates how many tracks will fit on a given side of a tape and (more importantly) then automatically programs the CD player's output to suit the length of the tape that you have chosen.

By pressing the edit Tape Length button, tape lengths of C46, C60 and C90 can be directly keyed in. Alternatively, other less common tape lengths may be keyed in, in terms of the required playing time in minutes and seconds available. Although C100 tapes were apparently not considered by this unit's designers, it is possible to key in 99 minutes and if you feel peeved about losing that extra minute, you can still key in that extra 59 seconds to get that much closer!

Whilst this approach to the editing process results in a cassette recording on which the original sequences are maintained, you may well still end up with a long gap at the end of side A of your cassette – as a result of your efforts to maintain the correct relationship between successive tracks on the disc. If, however, you do not place any great importance on the order in which tracks are recorded, or if there is more program material on the disc than necessary if tracks are not to be split, then you can optimise your tape usage by pressing the Just Time edit button. The SL-PS70 will then automatically work out the optimum order for playing the tracks on the disc so that both sides A and B of your cassette recording are used to the fullest extent. This will then ensure that the least possible amount of blank space is left on the ends of your cassette tape.

All you have to do is key in the length of the cassette tape and the CD player shuffles through the data stored on the data track at the start of the disc, and tells you which of the tracks it proposes to allocate to side A and which to side B – also showing you in which order they will be played to optimise the available tape length. All this takes the microprocessor less than 20 seconds to compute, which is natty and convenient.

I tried to do the same calculation in my head and found that I came out a very poor second in the race. It was as though I was using an abacus in competition with a computer.

The SL-PS70 incorporates other desirable features, including the Fade In/Fade Out function that enables the unit to start playing a track with a gentle ramped increase in the recording level, and similarly to fade out of a track with a gradual decrease in the recorded level. The only other consumer player or recorder which I can recall to offer this feature was the Nakamichi 'Dragon' cassette player, and that was all of six years ago.

Last but not least, the SL-PS70's most important other feature is its adoption of a remote volume control function, which I regard as being absolutely essential. This particular control is however, different from the volume controls provided by other CD players, as it provides six 2dB steps. The CD player briefly flashes the amount of attenuation relative to the full output in dB on the main display, when you change the volume level setting.

Other useful features which this player incorporates, which may be regarded as being convenient by some owners are as follows:

1. An Auto Cue function, which allows you to play one track at a time and wait there ready to play the next track at the touch of the Play button.
2. A display On/Off button, which allows you to dispense with the lower and then the upper segments of the display in two stages. The upper and main section of the display shows track number, index number, and time in minutes and seconds. The lower section of the display shows the number of tracks on the disc and those remaining to be played.
   Thus lower display can be deleted by one touch of the display On/Off button. By touching the button twice, the main display is extinguished and all you are left with is a small red 'Standby' display to stop you from worrying about whether the player has died or not. It you touch the display a third time the display reverts to its original condition, and you are re-assured with all of the data again.
3. The unit also incorporates the (now) conventional Program Play function, which facilitates the programming of up to 20 tracks in any desired order.

As I observed, the front panel is neat but not exciting, with the controls grouped in four distinct levels – the lower two of which are large and well labelled. But regrettably the upper two levels are small, and require reasonable vision and good illumination for inspection.

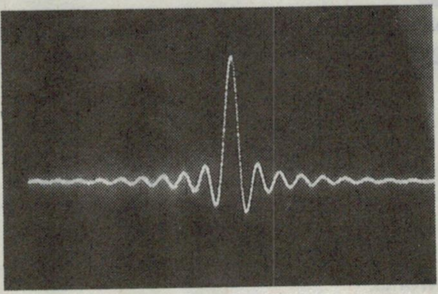
Construction

The player is lightly constructed, as I have now come to expect from all of the CD players in the low price to mid price bracket. The disc Holder itself is lightly constructed from plastic, is relatively noisy in its operation, and produces peak levels of 56dB(A) at one metre during the opening or closing cycle. This charactistic would inhibit its use in television or radio studios.

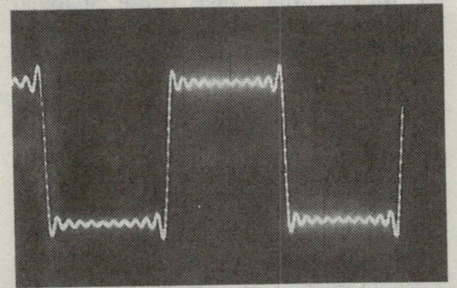
Dimensions of the SL-PS70 are 430 x 333 x 226mm, and it has a mass of 5.2kg.

Measured performance

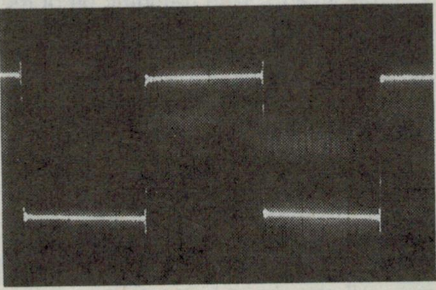
TECHNICS SL-PS70 CD PLAYER



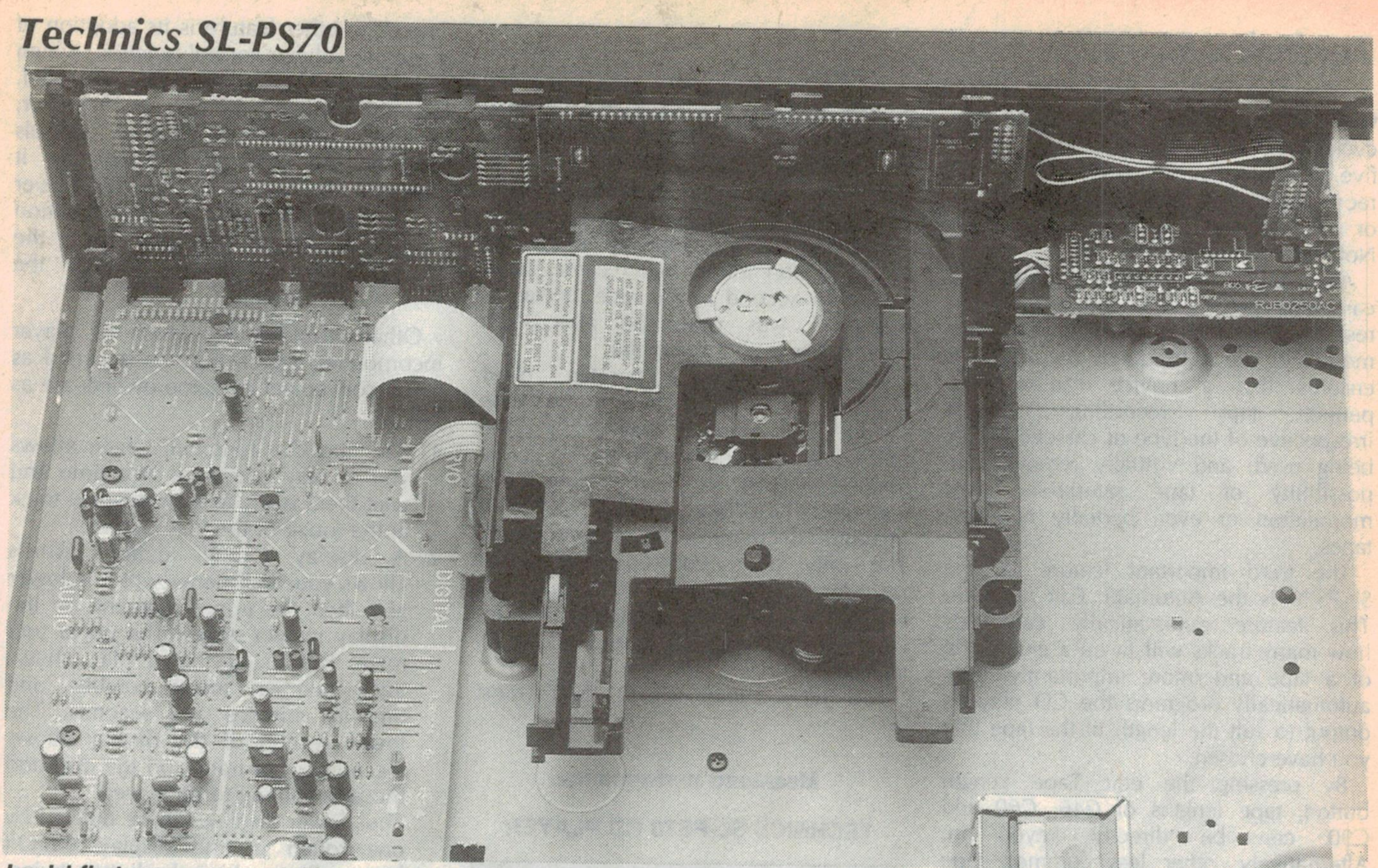
Impulse response



1kHz square wave



100Hz square wave



Louis' first response on taking off the cover of the Technics SL-PS70 was "Where are the IC's?" As you can see, they're tucked away out of sight. In fact there's quite a bit of space, inside the case...

The back panel incorporates a pair of conventional gold plated RCA terminals, an optical output terminal for connecting to other equipment, a 'Synchro-edit' socket for connecting to the corresponding connector of other Technics products, and a small recessed mains socket for connecting the mains lead provided.

The inside of the SL-PS70 is quite unlike any other CD player I have yet seen — there was just so little circuitry to be seen on the main printed circuit board. It's not that the main printed circuit board wasn't there, or even that it did not have components on it; but rather the type of components were typically resistors, capacitors and a few transistors, and virtually no LSI or dual-in-line chips of the type which I have come to expect. I had a feeling that I'd been tricked and that there was a second printed circuit board hidden under the main board. Then I looked more closely and found that there were still plenty of LSI chips neatly hidden under the disc tray mechanism, and still more hidden behind the front panel mounted control and display boards.

The lower panel of the CD player incorporates a double structure of metal and plastic to ensure better electrical isolation and increased stiffness. All in all, although the SL-PS70 is well made, I still had qualms about this new 'one bit' technology. This was because the number of chips provided were apparently a fraction of those provided in the second generation CD players, which I believe have performed so well. Obviously this warrants a reappraisal of the new technology and most particularly how it works.

The marketing material provided with the MASH (Multi-stage Noise Shaping) one-bit CD players) indicates that these particular players exhibit significant differences to the Philips players, and I expect are quite different to the other manufacturer's players, as well. The first differences comes as a result of the technique they adopt for converting the '16 bit' data from the disc into a stream of 'one bit' high frequency signals.

Technics have apparently adopted a 'bit compression' system by the use of a technique which handles the data in 'four-bit streams' with rounding off of the 'two bit' and 'one bit' data to overcome the need for a megahertz data bit rate. As they acknowledge, this results in some rounding off errors which manifest themselves as noise.

The MASH technology that they utilise was developed by Matsushita and Japan's Nippon Telegraph and Telephone Corporation (NTT), in which the noise is primarily at very high frequencies and the desired signal at low frequencies — which facilitates the adoption of a simple filtering technique, so that the unwanted interaction of the high frequency noise with the audible signal is neatly avoided.

After being compressed into a 'four bit' data stream and following the signal processing in the MASH circuitry, the data is converted into quasi 'one bit' data in a pulse-width-modulation stage, which is the point in the process where the signal becomes an analog signal. This stage of the processing occurs on the large printed circuit board, which obviously requires no fancy LSI or large integrated circuits, and thus accounts for the paucity of conventional digital circuitry on that board.

The proof of the pudding is of course, in the eating, and that's exactly what we set out to do in our laboratory.

Measurements

The measured results of the Technics SL-PS70 are particularly good. The first thing that you note is that the frequency response is absolutely flat all the way up to 5kHz, and slowly rises up by about 0.2dB before dropping off just before 22kHz. The top-end frequency response of the Technics unit is not as flat as that of the Philips unit, but I doubt that you will be able to detect the difference.

Technics SL-PS70

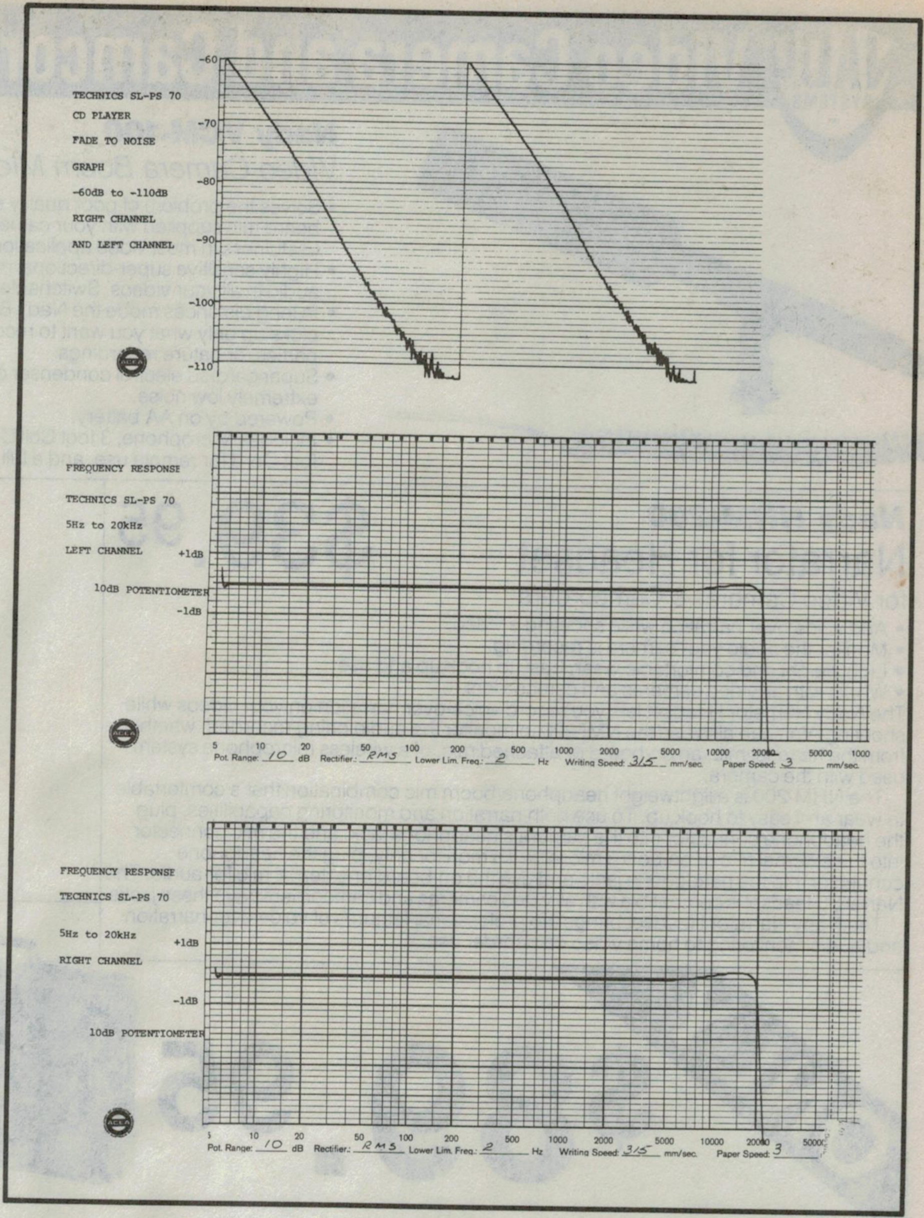
The digital transfer linearity of the SL-PS70 is ruler flat down to –70dB, but is not quite as flat between –70 and –110dB. An examination of the 'fade to noise' test results, reveals gentle downward curvature after –70dB which becomes a little more pronounced at –90dB, and then rises again under the influence of noise at –100dB. Even so, the frequency linearity in this region is still particularly good, and well on a par with the best linearity figures we have seen to date from conventional 16-bit and 18-bit players.

The channel separation at low frequencies is exceptionally good, and nobody can scoff at figures in excess of 100dB. The channel separation at 20kHz is down to 82dB and 78dB respectively from right to left and left to right channels, which are still quite acceptable.

The total harmonic distortion figures are excellent all the way down to –70dB, at which point they are a shade over 1% – which is good. Even at –80dB the THD has only risen to 4%. Obviously at –90dB with only a 'couple of bits' to play with, one must expect a rise, but even the THD figure of 19.7% at 1kHz is still quite commendable, and almost equal to the best figures that we have previously measured. The distortion figures at lower and higher frequencies are particularly good.

The linearity of the emphasis levels are good, but not superlative, while the signal to noise ratios are very good – with S/N figures of 111dB(A) without emphasis and 113dB(A) with emphasis.

The frequency accuracy of the CD player is good and the 'laser tracking system' exhibits no deficiencies whatsoever on the 'dirty test record' black dots or black stripe tests.



All in all, the objective tests display excellent results, which would most probably require a CD player costing five times as much in order to be bettered.

Listening test

The subjective evaluation of this player was a real delight. As well as using a number of conventional discs, I had the first of the Philips 20-bit technology discs with Mitsuko Uchida playing Claude Debussy's '12 Etudes' (Philips 422 412-2) and two of the latest releases of Sony Classical's 20-bit technology discs which have just come on the market.

The '12 Etudes', although beautifully recorded, do not necessarily provide the type of software which enables the CD player to show its best performance. By contrast John Williams conducting the Boston Pops Orchestra in 'Music of the Night', (Sony Classical SK 45567) really does. This particular disc which was mastered and produced during 1990 has tracks from all of the top Broadway shows including track 10, 'Suite from Miss Saigon' which members of my family have already seen in London and which has just hit Broadway. It also has the 'The Trolley Song' from *Meet Me in St Louis*, which is obviously one of my favourites.

An even more exacting piece is the third of these new discs, with Carlomaria Giulini conducting Mozart's 'Requiem' KV 626, (Sony Classical SK 45577). This is the last haunting piece of music from the film *Amadeus*, in which the choir emplores God to grant peace to the souls of the departed, and around which innumerable myths and legends have grown.

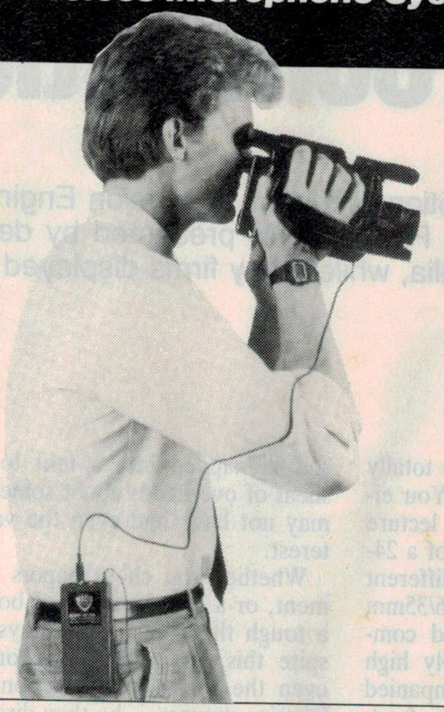
By-passing those legends, the combination of low noise, excellent linearity, low distortion and superb recording on the disc combined with the excellent characteristics of the CD player convinced me that Sony's '20 bit' recording technology really does deliver the goods, and that it is ably abetted by the excellent performance of the Technics SL-PS70 player.

I have had this player at home now for all of three weeks, and in that time I have been impressed by its 'straight performance' as well as by the innumerable special facilities which it incorporates. Considering that this is a medium priced player, my impressions are that it poses quite a threat to just about everybody's 'top of the line' CD player.

Recommended retail price of the Technics SL-PS70 is $659, and it's available from all Technics hifi stockists.

NADY 151 VR

Wireless Microphone System for Video Cameras and Camcorders



- Puts the microphone "where the action is" for professional quality audio on your tapes
- The NADY I5IVR Wireless System will make an amazing difference in your vidoes.
- Range is 200ft.
- Works with all video cameras and camcorders having an audio input.

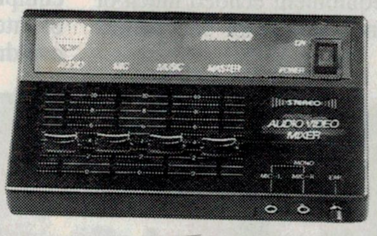
$399.95

$399.95

NADY'S AVM-300 VIDEO MIXER

$99.95

- Four channel audio input with separate gain control and full mixing capability.
- Economically designed control board for ease of use.
- Dynamic microphone for high-quality voice recording.
- Compatible with all camcorder makes.



Nady's AVM-300 Video Mixer brings music and narration to camcorder videos with a design that emphasizes ease of use and compatibility with a range of audio and video components.

The AVM-300 accepts up to four channels of input with a separate gain control to for each. This allows users to combine music and narration, or fade in and out of different pieces of music with ease.

The Mixer's master gain knob controls the volume level of the finished product, and a dynamic microphone that's highly effective for both voice and music tracks completes the fully integrated package.

The mixer feeds from a camcorder's audio output, along with its own microphone and up to two other audio sources. All of these sources plug into the back of the compact, ecoonmically designed unit. After hooking up the audio, the user then plugs the camcorder and mixer into a VCR and adds sound while viewing the video on-screen.

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Sound & vision '90: SMPTE's Sydney Convention

The Fourth International Conference of the Society of Motion Picture & Television Engineers – Australian Section was held in Sydney in July this year. Papers were presented by delegates from the USA, Britain, the Netherlands, Japan and Australia, while many firms displayed a huge array of state of the art equipment.

by BARRIE SMITH

The subjects of Conference papers ranged widely: motion picture technologies, HDTV, digital audio and video recording and processing techniques, computer and video graphics, high band small-format video recording systems, editing techniques – and on the last day, a report on how the Nine Network covered the 1990 Commonwealth Games. Something, seemingly, for everyone.

Additionally, in three adjacent halls a vast array of equipment echoed much of the subject and content of the papers delivered.

The three and a half days were totally insufficient to take all of it in. You either wedged yourself into the lecture hall and rolled with the barrage of a 24-hour total of good/bad/indifferent speakers, accompanied by 16/35mm film, slides, projected VTR and computer images – shown in overly high ambient light, and often accompanied by shaking projection and audio feedback; or you trudged from stand to stand squinting at overlit 'sets', underlit equipment, displays and demonstrations of interesting technology so popular you couldn't get near, perhaps finding yourself kidnapped into a tent to watch a sheaf of overheads about something you may not have had even the vaguest interest.

Whether you chose papers or equipment, or a judicious mix of both, it was a tough three and a half days. But despite this, essential for anyone having even the remotest connection with the imaging process – be they director, editor, cameraman, engineer, or those at management level.

During the week the A$ lifted over US80 cents, whilst the temperature fell to 7°C. I couldn't help comparing the

Short focal length lenses do distort things just a tad, but in this case it also gives a good impression of the vast scope of SMPTE 90's exhibition.

level of our currency with that prevailing at the previous SMPTE of 1986 – just US66.35 cents and 6°C – and wondering whether, in spite of the parlous state of our TV and film industries, brave hands may dig into bare pockets and take advantage of the high rate, and embark on big re-equipping programs.

At least, in this violently changing world of ours the winter temperature remains relatively constant!

As I listened and learnt throughout the three and a half days of the show, one thing became obvious despite the volatile nature of the imaging business in this, the final decade of the second millennium. This is that film is to be seen less and less, video more and more.

One estimate was that there were fewer than four exhibitors in purely film terms in the whole show. But whilst the actual physical presence of silver imaging and its attendant hardware and technology was less than dominant, a number of interests are determined to position film as the major imaging process in the years to 2000 AD and beyond.

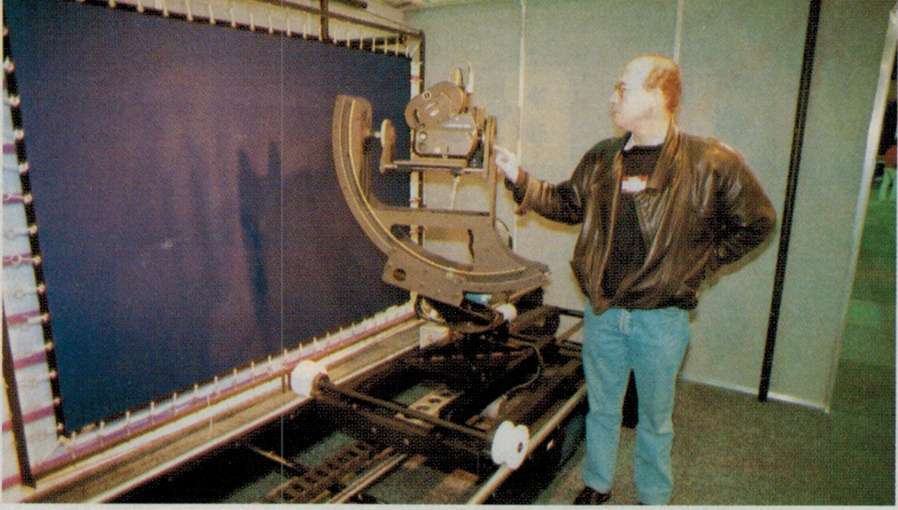
There was much in the air about 'change' – not only in the air, but actually in the exhibition halls themselves.

Sony, JVC and Panasonic (to a lesser degree) are putting their highly effective shoulders to the wheel of Hi Band small format videotape – in the guise of Hi8 and Super-VHS, respectively. And the companies are aiming high – nothing less than full level, broadcast quality.

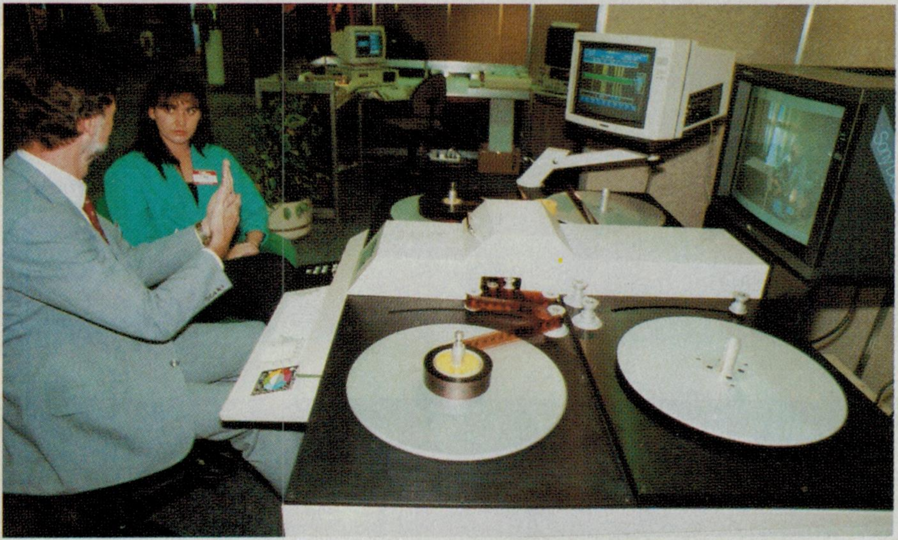
Sony is convinced a Betacam edit is the way to post-produce Hi8 original shooting; whilst JVC is convinced producers should stay in S-format. As proof, the latter exhibited a most impressive OB van with cameras and edit suite 'ready to go' – in Super-VHS.

JVC is staying with 'good old-fashioned' magnetic oxide tape for S-VHS, claiming there is little difference to metal particle tape in its structure.

To achieve the necessary multiple generations required in professional post production, a number of circuitry changes have been incorporated into S-VHS: an adaptive circuit has been inserted to eliminate vertical colour blur; a chroma enhancer to improve edge definition, especially on multi generations; an improvement in the chroma bandwidth from about 0.5MHz to about 1.2MHz achieved; plus the incorporation of chroma noise reduction circuitry, and automatic equalisation – the latter to restore lost luminance signal frequency response.



Australian Matt Butler with his locally developed portable camera motion control system, which weighs no more than 200kg.

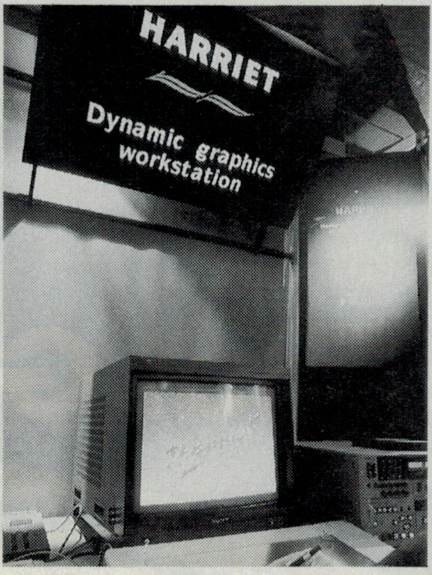


At the Filmlab stand was the company's Colormaster film colour analyser, constructed in Caringbah NSW using software written in the UK.

Additionally, the tape path itself has been stabilised by adding an impedance roller to the start of the head wrap.

The effect of all these changes I was able to see most convincingly, in a demonstration of a fifth-generation copy made on VHS – and S-VHS. It would be hard to deny that the latter format is well-suited to multiple generation copying.

Everywhere you walked, Amiga computers shone their glittering screens. Apart from the Commodore company's Andy Warhol stand, replete with junked bakelite radios, pick handles and warped vinyl records that weightily said 'the end is nigh' for traditional video graphics techniques, the machine seemed to pop up at the most unexpected stands. For instance, MVRP – a company selling autocue hardware with reflective 'windscreens' to bounce the script at the speaker – recommended the Amiga, floppy loaded, as the ideal source of text supply.



Quantel's new Harriet video graphics workstation – a dynamic setup with totally random access solid state storage.

Wide Band Receivers...

ICOM has broken the barriers with it's new line of wideband receivers built to go the distance. Introducing the IC-R1 handheld receiver, the IC-R72 HF receiver and the IC-R100 multi-purpose receiver.

IC-R1. The smallest wideband handheld available today, the IC-R1 continuously covers 100kHz-1300MHz (Specifications Guaranteed 2-905MHz) with AM, FM and Wide-FM modes. This tiny receiver measures just 241mmW x 94mmH x 229mmD.

Easy operation is a snap with the IC-R1's Dual Frequency Selection (direct keyboard and rotary tuning). 100 memories and a 24-hour clock completes the world's smallest full-featured handheld receiver.

IC-R100. Install the IC-R100 at home or in your car. Listening pleasure is guaranteed with continuous coverage from 100kHz-1856MHz (Specification Guaranteed 500kHz-1800MHz) in AM, FM and wide FM modes. Monitor VHF air and marine bands, emergency services, government as well as amateur stations. 121 fully programmable memory channels, multiple scanning system, an automatic noise limiter, built-in preamplifier and attenuator, clock with timer and built-in backup lithium battery make the IC-R100 the perfect package for mobiling or base operation.

IC-R72. The IC-R72 continuously receives 100kHz-30MHz in SSB, AM and CW modes with very high sensitivity. An optional UI-8 provides FM reception. Additional features include: Noise blanker, five scanning systems, AC/DC operation, internal backup battery, built-in clock and ICOM's DOS System. The IC-R72 boasts a 100dB wide dynamic range while an easy-to-access keyboard provides convenient programming versatility. The easy to operate IC-R72 is superb for short wave listeners.

The IC-R1, IC-R72 and IC-R100 join ICOM's current line of professional quality receivers... the IC-R71A, IC-R7000 and IC-R9000. ICOM... expanding the horizons to bring you better technology, today. See the complete line of quality ICOM receivers at your local authorized ICOM dealer today.

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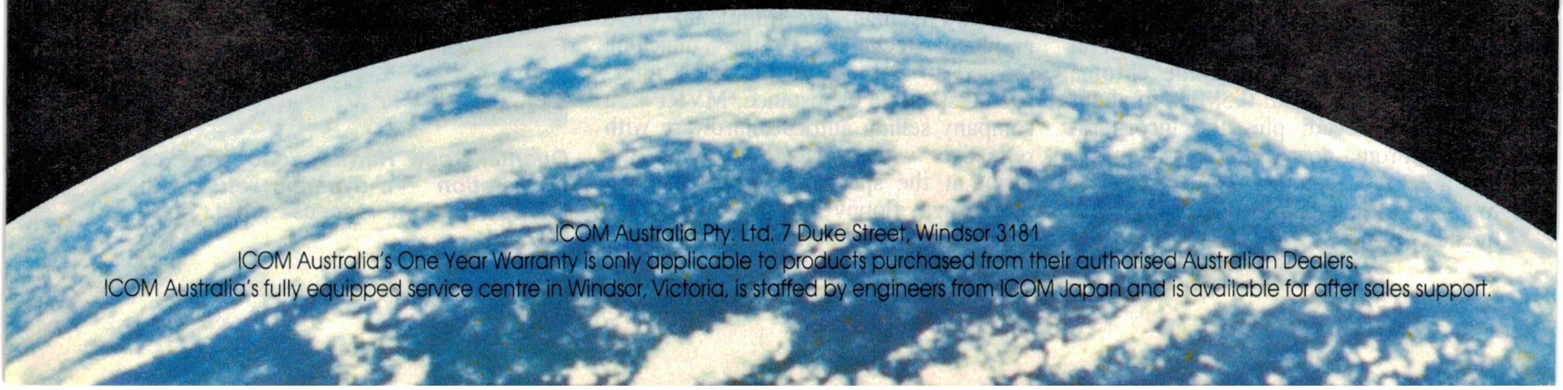

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SMPTE '90

HDTV thrust

What did emerge as the major thrust of the conference was HDTV (high definition TV) – with papers on the Japanese and European systems, added to which were the concerns (and apparent bewilderment) of the American broadcasters unaware of which way to go. Oddly, we saw no demonstrations of any of the systems – in the lecture hall or exhibition forums.

But you realise HDTV must be getting close when a company does a teleconferencing stint from its Hong Kong office to the US – using HDTV image capture bounced up and down on the dish.

I use the word 'close' only in the sense that some parts of the world are to receive regular broadcast high definition television as soon as next year – namely the Japanese and the Europeans.

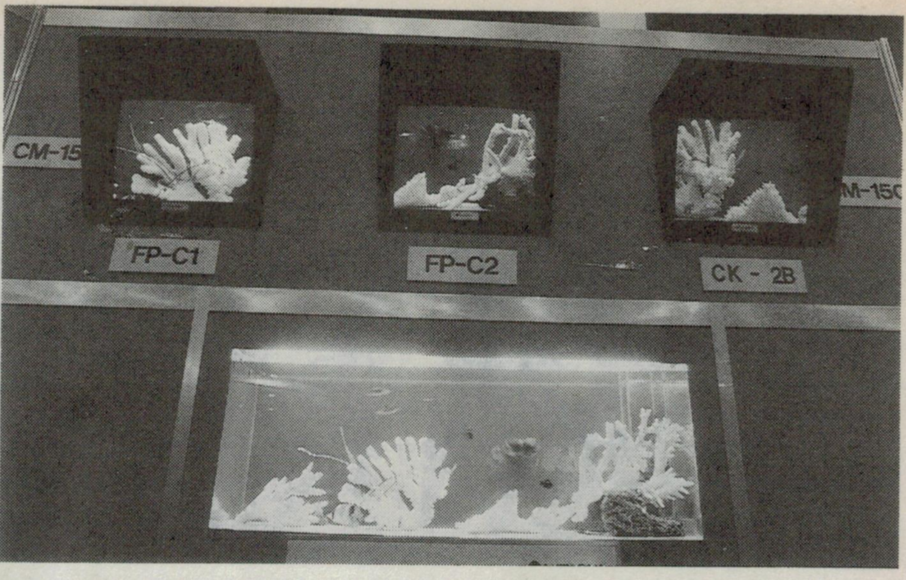
It's surprising to realise the HDTV concept was first mooted in 1964. The first showing – using three cameras, and three sectional images – was in 1971. As one speaker remarked, even colour didn't take 27 years to cover parts of the globe – but then colour didn't have to fight its way through a forest of national and corporate jealousies in disagreement on standards.

There are already a cluster of standards for HDTV, and none of them is 100% compatible with the others.

In the opinion of Carlos Kennedy of Ampex USA, to live with the existing standards conflict we may well end up with a multiplicity of HDTV formats – globally speaking.

And this is where the silver interests come in, particularly those of Eastman Kodak, with its eye firmly set on bridging the entire range of HDTV standards using one common imaging medium – film.

The company has embarked on a quest to provide the major link between any standard that may emerge – whether it be MAC-D2, MAC-HDTV, HDTV Muse – in NTSC, SECAM, or PAL based systems. 1989 saw the company introduce a range of professional motion picture emulsions – EXR – that exceeded existing standards of resolution, colour fidelity and shadow 'reach'. The company predicts that no other medium – analog or digital – is likely to match the performance of these films until at least the end of the century.



Hitachi's camera demonstration display used a colourful fish aquarium as the 'set', with monitors immediately above for comparison.

Kodak sees its 35mm colour film as the ideal common imaging standard for original material intended for HDTV – whatever the system.

Additionally, the company has embarked on the production of an HDTV telecine, specifically aimed at the transfer of high quality film to any HDTV standard that may be around – whether 1125/60Hz, 1050/59.84Hz or 1250/50Hz. Together with a partner (presumed to be Rank) an experimental telecine has been developed using advanced CCD sensor technology. Their design approach is novel to say the least: using CCDs as the image receptor, the luminance and chrominance signals are produced at differing rates of resolution.

Also under development is a high resolution 'intermediate' system, aimed at the motion picture industry and its need for high quality image manipulation in the post production stages – what used to be called 'optical effects'. In this scheme, film would be digitally scanned and loaded into storage on a computer work station; here image manipulation, colour enhancement and titling would be performed in the digital domain.

Following this stage the data would be returned back to film – in high resolution format. In experimental form both the scanner and recorder exist; some of the technology is being tested at George Lucas' Industrial Light & Magic complex, in Hollywood.

In other areas the industry also shows determined moves to integrate electronics and the 160 year-old craft of silver imaging.

Keykode is a new method of edge identifying frames and metrage of motion picture film by using a bar code system, plus human-readable numbers. In the film editing process, once the work print is cut, the negative is matched by using an edit list generated from the code – or the edit information can be fed directly into a video editing controller, for those projects being finished on videotape.

Cinema Digital Sound is expected to be the big event in the cinema for the 90's. Kodak and Optical Radiation Corp have worked together to place the equivalent of CD sound on motion picture film, without the need for magnetic stripe, or separate sound reproducers. The digital sound mix is recorded optically, alongside the image, on the customary edge track. The print film's information capacity of 5.5 million bits/-second is used to record six discrete audio channels – five at full bandwidth, and another for low frequency signals. Additionally, control tracks are available for in-house effects, synched with the film: for triggering strobe lights, or activating hydraulics to control seat pitch and roll, or whatever else may occur to effects-crazed producers in the future.

One gets the impression that, very soon, the cinema will no longer be the place for a quiet kip during the boring bits!

The papers

An early lecture was an interesting talk (for computer buffs) on how Ampex has developed a real-time 'graphics engine' to produce high quality graphics, with lower hardware and

The Commodore Amiga stand – pop art plus 16 screens of mid-level computer video graphics.

software costs. Ampex avoided the conventional frame buffer, and instead went for a 'pipeline' concept, with the desired picture information being regenerated each field. The engine has been used in the company's new *Alex* dynamic character generator.

Nigel Wake of Greater Union gave a well-prepared, thoughtful and controversial paper on the future of cinema, revealing where his loyalties lay by saying:

"If God had meant us to see and hear in digital he'd have given us high definition converters for eyes and ears – and a microprocessor for a brain."

There were numerous views on HDTV, with contributions from Quantel, Kodak, Philips and NHK. Engineers in Germany are working on an enhanced PAL system – called *PAL Plus* – while Europe is already committed to D2-MAC for a 1991 launch. One Melbourne delegate pointed out that NHK were shooting some material in the Super-16 film format for their current, hour-a-day, Japanese HDTV transmissions.

Other matters covered were broadcast equipment, a user-friendly electronic film editing system, a heartfelt plea from a Canberra gentleman against TV aggregation – and of course the tale of how the Nine Network covered the 1990 Commonwealth Games for Australia in Auckland, using seven cameras, six edit suites and 24 VTRs.

The exhibition

Motion control technology allows a film camera to shoot precise and repeatable movies on multiple, motorised axes; not only can the camera dolly's forward/rearward moves be pre-set and repeated, but also such camera functions as pan, tilt, zoom, etc. This allows the subject, backgrounds and superimposing key films to be shot in exact fit and synchrony.

An Australian, Matt Butler, has developed a location version of this complex tool, weighing no more than 200kg. The system is based around a Lynx Spectrum Robotics software/hardware package developed by special effects company, Apogee USA.

Tied in with this is a 7x5 metre blue screen to provide subject/background separation, lit by pure blue fluorescents running at 30kHz. These are wrapped in magenta gels to eliminate green spectrum components.

Vinten, the English company responsible for Canberra's Parliament House TV installation, also offered a form of motion control – in real time. With their *Microswift* system the day of the remote operated TV studio is now with us – robotic mountings control pan, tilt, zoom, focus, camera elevation and physical position in the studio. Now the director can actually 'phone it in', and control coverage by up to eight cameras from any remote point.

Remaining within the context of remote camera operation was one exhibitor's snorkel lens, looking no more distinguished than a length of 1/4" aluminium tube – but it had the ability to capture views underwater, to a close focus of 2mm, and supply its own daylight quality light source. Connected to a BTS LDK90 broadcast video camera, the lens picked up screen-filling close-

AFTERTHOUGHTS...

One of the smoothest and best looking presentations at SMPTE '90 was by Mark Richards of Dimension Graphics, using a computer-generated picture source. He effectively destroyed all competitive imaging and display methods one by one, until delivering a *coup de grace* to a carousel of colour slides – by tripping and spilling the entire load onto the floor. At this point he quoted a US university finding that in 1981 there was sufficient production of colour slides globally to give one to each and every one of the world's population. Which research prompted a letter from an un-named writer pleading: "I didn't get mine".

At this point in time the computer systems from Amiga and Apple on show at SMPTE had a lot of promise – if coming in short at the moment, as far as smoothness and dynamic control. But time will tell. With paintbox systems still nudging $100,000 for base line systems, there's plenty of room for the two A's to move into the field.

The feature shot on Betacam SP – *Say A Little Prayer* – was unfortunately in a state of suspended animation when a medley of scenes was shown at SMPTE. Apparently the production had run out of money, which is a common problem with Australian features. This seems a pity, as the tape-cum-film is budgeted at $200,000 plus a low cost of $100,000 to finish the production to film stage for cinema release. And the subject – sexual frustration – looked most interesting.

But Carlos Kennedy of Ampex USA gave the conference the last laugh, by his decoding of two well-known industry acronyms:

As most people are aware, NTSC is widely known as Never Twice the Same Colour. Carlos declared the French were so determined that their TV system should exhibit no visible parentage from across the Atlantic that SECAM should be Something Essentially Contrary to the American Method; whilst the Germans justified their own labours on the PAL format with the modest description Perfection At Last.

ups of goldfish eyes from beneath the surface of a mini aquarium.

The challenge is now thrown out to a producer who can make use of this odd tool!

Maxwell Photo-Optics showed a number of newish Nikon products, including the CP-300 Full Colour Printer using thermal sublimation dye transfer technology, and capable of producing high definition prints from computer and video sources. Along with the LS-3500 Film Scanner, which is making rapid inroads into desktop publishing, this is the kind of machine which is changing the reproduction of the printed colour image.

I felt Nikon missed a golden opportunity to capitalise on a 'film' shot in videotape on Betacam SP, transferred via a Sydney company's kine process to 35mm Eastman Colour, and shown on the first day of the conference. Superb quality on film. The lens? A Nikkor 15:1 zoom.

Deserving of a tableau of its own was the 'star' of the John Barry stand – the Arriflex 535 – described in the September issue of *Electronics Australia*. Speaking with Jorgen Sahlmann, Arriflex Munich's Export Sales Manager, I learnt there were only 14 of these half-million-dollar cameras in existence, most of them on back order.

Barry's also showed the Anton Bauer range of portable lights and batteries, aimed at the pro video camera market. Their extremely compact 12V ultraLight units clip onto an ENG camera and can produce up to 700 foot candles of illumination.

Sydney film equipment company Filmlab is now winning international export sales with its *Colormaster* film colour analyser. Using a three-cell CCD sensor, digitised video and computerised signal processing the unit allows an operator to preview a colour negative as a positive image, and apply necessary corrections frame by frame, or at normal running speed. The mechanics are produced in Caringbah, NSW with the computer software coming from the company's UK subsidiary.

The 1990 exhibition showed once again the dominance of video, with the major hardware manufacturers showing serried ranks of cameras, VTRs and graphics processors.

Companies such as Ikegami, Hitachi, Mitsubishi, BTS, Sony and GEC-Panasonic presented the regulation row of studio cameras, studiously aimed at a representative studio 'set'. Ikegami used a toy shop to put their cameras through their paces, whilst Hitachi's choice of subject was an aquarium; BTS used a pastel-toned newsreader in a softly lit news-set; Sony went for a sail-maker's loft with gaily coloured dacrons hoisted to the roof; GEC-Panasonic, however, felt the chilly atmosphere called for a bit of *pizzazz* in the chroma department, and filled a corner of their stand with a fruit and vege display that would have been at home in any Italian greengrocer's shop.

Sony's broadcast camera demo stand, which used a colourful sailmaker's loft as a 'set'. The lineup included the new BVW-370P camera.

Panasonic is still committed to the MII broadcast format, which appears to be stagnant – at least in this country. Although it was used by an English crew recently in this country, shooting *Keith Floyd in Australia*. Their product range carries MII, VHS and S-VHS. S-VHS is catered for with four models of camera, two of which being three-CCD and Y/C signal capable. And a raft of editing controllers in S-VHS.

The company's WV-BL600 camera – a black and white model for industrial applications – has a low light sensitivity of 0.05 lux and a claimed 500-line resolution via a 1/2" interline transfer CCD chip.

Dropping further into the gloom is the BD900 *Nite Hawk* camera – able to operate at 0.0015 lux. It uses a 2/3" CCD, linked to a fibre optic plate, and its signal is gen-lockable.

Ampex displayed a new range of studio digital VTRs in its VPR-200, VPR-250 and VPR-350 D2 format recorders, plus Betacam SP camcorders and studio recorder/players, a new low cost three machine editor, and the *ALEX* character generator.

Magnatech carried its range of Aurora video graphic and animation work stations, and the industry standard *Chyron* character generator and graphics systems. New was the *Scribe Jr*, a dual-channel unit that allows the operator to control two independent air-quality displays.

In the same area of graphics generation and manipulation were Quantel, Grass Valley and Abekas.

Quantel's new *Harriet* graphics work station is a dynamic setup with totally random access solid state store, plus full VTR control.

Harrytrack plugs in full digital stereo for the *Harry* suite, now gaining a foothold in production environments across Australia. Now you can have digital graphics, editing, and sound – all in one neat suite.

'Corner pinning' was the buzz word of SMPTE '90. *Harriet* had it, as did a new interface for Abekas' A53-D digital effects system. Corner pinning allows the user to select any of the four corners of a compressed image and, without moving any of the other three corners, easily tack each selected corner to any point of the screen. Add another program called *Solid Builder*, and you can easily create multi-sided solid geometric objects that can be moved freely in three dimensional space.

SMPTE '90

Artarmon, Sydney company Bobdog is fast moving up in the TV commercial post production scene. One of its aids is the software *Softimage 4D*. The company distributes the package, trains users in its intricacies and will design clients' systems. The program can handle most of the standard functions – edits, mix, keys and mattes. It also produces offset images and mattes for drop shadow, blurring, generation of shadows, reflections and refractions.

BTS – the company jointly formed by Bosch and Philips – put some weight behind its Diamond Production Switcher. More with less is the Diamond's approach – the capacity to switch more program sources with fewer operating controls; 30 inputs to the mix/effects stage, and the ability to reduce controls to a bare minimum. The company's highly-respected LDK90 and 900 frame transfer cameras continue in production, showing that CCD technology at studio broadcast level has plateaued.

Sony took up most of a separate building, with much of interest. There was a whole roomful of audio gear, including the company's new, universally compatible DAT recorders – now time code aware and video friendly.

A star line up of CCD cameras, including a new studio camera the BVW-370P was available for try outs. A new D2 format digital VTR was also on show, weighing only 12kg and taking PCM audio into the field. There were also four editing and effects suites.

Impressively present was the new DME9000 digital multi effects system, with real-time texture mapping capability. The operator demonstrated how objects can be twisted and deformed in the most tortuous manner, while real-time video was mapped to the surface.

In Hi8 the EVV-9000P videocassette recorder caught the attention, weighing just 6kg, hooked on to the DXC-325P camera and lens. It's time code capable.

The company is showing a firm commitment to Hi8 as a semi-pro and full pro format. Sony personnel recently ran an Australia-wide promotion of the gauge to show its advantages in size, weight, longer recording time and low power drain.

There's also the LVR-6000P Laser Videodisc recorder in WORM (Write Once Read Many times) format, taken up with alacrity by the ABC for the 1990 Federal Election broadcast. The unit is capable of record/replay of 24 minutes or 36,250 frames per disc side of broadcast quality video and PCM sound. The latest model, LVA-8000P, is a player only, in component signal configuration.

Agfa announced the introduction of an Anti-Tampering Splice Proof video splicing tape. It is aimed at tape duplicators, and is intended to help identify tampered video cassettes. The splicing tape can be custom-printed with logos, copyrights or graphics; the subsurface printing process cannot be erased or pirated, and has no effect on the video image. There have been cases of unauthorised splicing of regional advertisements into rental tapes, and occasional substitution of lengths of original tape.

Still in audio: Greater Union debuted its professional products division by displaying a range of names well known overseas: Raindirk, Genelec, Aries, Summit, BASE, Apogee, Furman and JL Cooper. The small stand was dominated by Raindirk's *Symphony* multitrack mixing console, offering an impressive 72 channels and 32 outputs.

So every facet of film and TV production appeared to be covered in this year's SMPTE '90 – thrice over. EA

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Special Cover Story:

SBS TELEVISION: THE FIRST 10 YEARS

SBS TELEVISION

October 24th marks the tenth birthday of SBS-TV, Australia's unique multicultural broadcaster. David Flynn examines the technology behind the network, and what has been achieved in the first decade.

Almost every Australian has seen or at least heard of SBS Television. In any incarnation – as Channel 0, Network 0/28 or SBS-TV – the unique multicultural broadcaster has entertained, enthralled, educated and at times outraged its ever-growing audience. A grab-bag of technology, transparent behind the pictures and sound, makes SBS what it is.

"We are a lean, efficient organisation" says SBS Head of Television Andy Lloyd-James. "Some people say we run on the smell of an oily rag ... well, you can light a damn good fire with an oily rag!" This is the constant image of SBS-TV – a lone David in a world of Goliaths, which last year provided their special blend of alternative programming to some 10 million Australians for barely $40 million.

The SBS philosophy is to open up a whole world of viewing with quality material from all over the globe. This allows SBS-TV to compliment those services provided by the ABC and commercial networks, at the same time reflecting a contemporary Australian society which is inherently multicultural.

SBS takes the best of television from overseas – a detective series from Germany, a soap opera from Japan, a mini-series from Italy, and films both classic and modern. They also produce many of their own programs, from the acclaimed World News and current affairs to sport, music and general interest programs. About half of SBS' transmissions are in English, and those which aren't are subtitled in English.

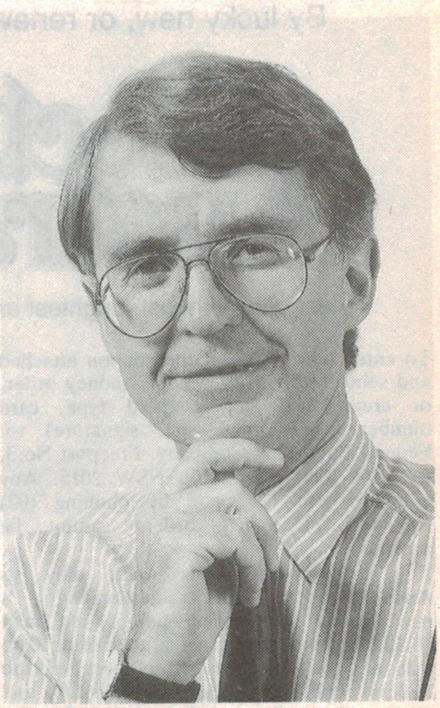
"There is that very old fashioned view that in some way SBS Television is all foreign languages; that they are all very difficult and very complex programs" says Lloyd-James. "But we're not some kind of odd art-house-round-the-corner, we are actually a very full-blooded television station with all the fun and excitement, and everything else that everybody else has. It's just that ours comes from all over the world, it's not limited to a couple of sources."

Nor does SBS compete in ratings battles. Rather, their audience is a selective one, based on present estimates that some three million viewers tune in nationally each week. "That's about a third of the available audience in the metropolitan areas" Lloyd-James points out. "They come to us for a single program and then go away. That's fine, we like people to come and have a look. What we're really trying to do is talk to all of the people some of the time. We're not a mass broadcaster."

SBS Television headquarters is a seven-storey office block nestled just off the harbour at Milsons Point, Sydney. Although there is a news bureau in Canberra, and an office and production facility in Melbourne, it is Sydney which is the hub of the SBS network. The one building houses SBS technical and engineering areas, news, subtitling, production, publicity, programming, marketing, administration – everything the modern TV station needs, all under one very compact roof. This is part of the legacy of SBS, which in early 1980 was given barely six months notice to build a complete television station.

SBS has only one studio, a studio which perhaps says more about the network than anything else. To begin with, it is small – not not much larger than a double garage. As unlikely as it may seem to anyone in the TV industry, SBS has made this tiny space work as a studio. Backdrops are suspended from tracks mounted in the ceiling, and can be swung into place in seconds. The ceiling tiles have been removed and the air conditioning ducts exposed, if only to add a precious few feet for mounting lights.

This attitude, as much 'can do' as 'make do', has been part of SBS since it debuted in Sydney and Melbourne on October 24th, 1980 – United Nations Day. Over the years, the service has slowly expanded to a present total of 36 transmitters covering capital cities, regional areas and towns across Australia.



Andy Lloyd-James, Head of SBS Television: "We're lean and efficient".

The SBS-TV time delay system. A bank of Sony 1" video recorders is used to delay programs fed to the Central and Western time zones – so that all are broadcast at the same local times.

SBS wings spread

This growth presented a new challenge for SBS engineers – the establishment of a true network, fed from a single point, ensuring national coverage and allowing for the local time zones of South Australia and Western Australia. The solution was two-fold, and represents some of the most important technical elements which set the SBS aside from other broadcasters.

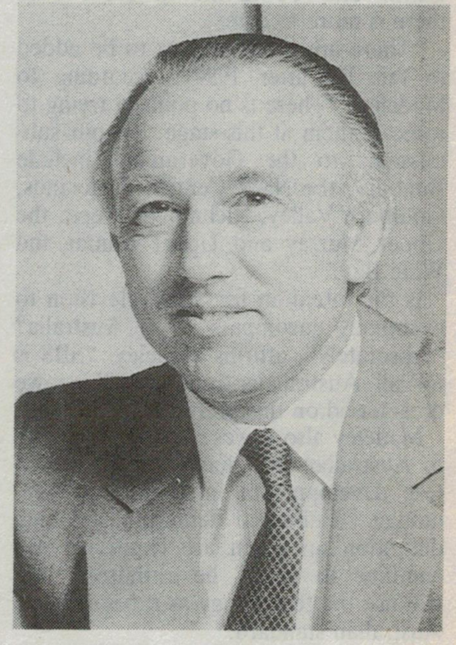
SBS' development into an Australia-wide service came in two stages. The first was the extension to Brisbane, Adelaide, Wollongong and Newcastle, which took place in June 1986. Perth and Hobart came on-line in March of the following year.

The first consideration was, how to deliver programs to these new regions? Until 1986, all reticulation was done via Telecom bearers, a chain of landlines and microwave links between Sydney, Canberra and Melbourne. Then SBS moved to satellite technology, and in doing so became one of Aussat's first customers.

"We could not have gone to Hobart and Perth had we not moved the whole of our reticulation to satellite" says Bryan Madeley, Director of Engineering at SBS. "The existing terrestrial bearers were fully used as it was, and the furthest we could get at that stage was Adelaide."

On Aussat's A1 bird, SBS uses a single 12-watt transponder covering south-eastern Australia. The footprint blankets the whole of NSW, Victoria and Tasmania, reaches across the borders of Queensland and South Australia and a narrow lobe into Perth – so the one beam feeds all capital city and regional transmitters with the exception of Sydney (which is sourced direct from the SBS studios).

The Aussat signal comprises one television and two audio channels for dual-sound stereo, plus additional audio channels carrying radio 2EA, 3EA and program interchange. As the satellite downlinks are not encrypted, they can be received on dish by anyone within the footprint – an avenue thousands of



SBS Director of Engineering Bryan Madeley: "Everything we do is based on the premise that SBS is for all Australians".

country folk have used to add SBS to their choice of regional viewing.

Madeley suggests that Aussat could play a continued role in the network. "If we were to stay with the satellite, our desire would be to reticulate all programs to exactly the same places and in the same way as the ABC. That is, a Western Australian beam; a Central Australian beam which would in winter service both South Australia and the Northern Territory (being supplemented in summer by another beam for Darwin), delayed one and a half hours; a north-east beam for transmission centres in Queensland; and of course our existing south-eastern beam."

This plan is based upon the configuration of Aussat's B series of satellites, due for launch in 1992, but Madeley allows for the impact of new technologies on the network. "In the timeframe we are talking about, there will be fibre-optic reticulation all around Australia. So the question is, which will be the best for us? We are looking competitively between Telecom and Aussat, and only time and price will tell."

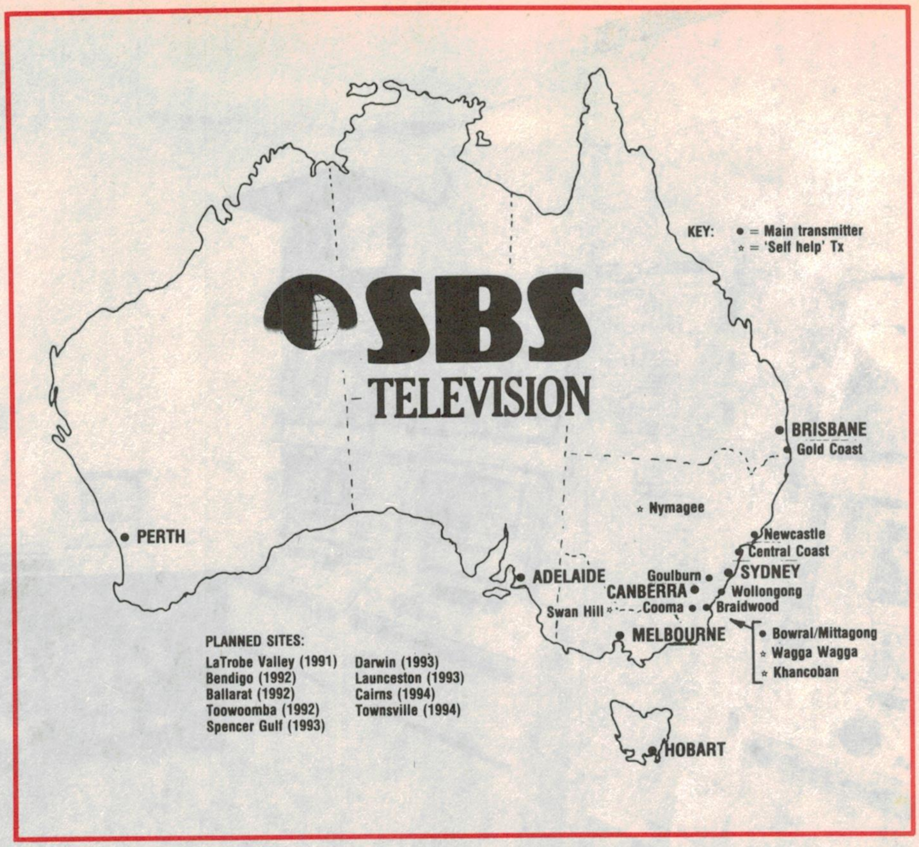
In the meantime, the web continues to grow. The Government has approved the extension of SBS-TV to the La Trobe Valley in 1991; Bendigo, Ballarat and Queensland's Darling Downs district in 1992; Darwin, north-east Tasmania and the Spencer Gulf in 1993; and Cairns and Townsville in 1994. And there is more to come.

"There are other regions to be added to this list after 1994", according to Madeley. "There is no point in trying to forecast them at this stage, but our submissions to the Government include Bunbury, the NSW Central Tablelands, Goulburn Valley, Richmond/Tweed, the Upper Murray and Upper Namoi and Wide Bay."

Is the intention for SBS Television to eventually encompass all of Australia? "Absolutely", affirms Madeley. "SBS is for all Australians, and everything we do is based on this premise."

Madeley also drives SBS to contribute to Australian implementation of the latest developments in broadcast technology. "Enhanced definition and high definition television are issues we will continue to press" he enthuses. "We will use the technology as it becomes an Australian standard."

"We are also looking very closely at Digital Audio Broadcasting, which has the ability to run co-channel on satellite or terrestrial feeder. If we are one of the people that the Government decides to fund for this, DAB means we can run programs with CD-quality. The present situation, you see, is that you now have better technical performance in most people's homes than broadcast systems can match, but the weak link is the transmission standard itself. This is the objective behind DAB, to provide suitable transmission quality."



Currently SBS-TV has transmitters in all capital cities except Darwin, and many regional cities. Nine further transmitters are also planned, before 1995.

Time delay system

One of the problems faced by a national network such as SBS-TV is the various time zones throughout Australia, a situation compounded by the states' lack of conformity on the observation of daylight saving or 'eastern summer time'. With a single national schedule sourced from one point, the provision of SBS-TV programs in 'local' time to each area required a unique engineering solution.

The answer was a time delay system (TDS), a sophisticated 'bucket brigade' designed under tender by Sony to rigid SBS specifications. The first of its kind in the world, the TDS records programs off-air on a series of 1" videotape machines, and then replays this material once the necessary time has elapsed.

Consider the time difference between Sydney and Perth – two hours most of the year, and three in summer. The TDS, located at Perth, receives SBS programs direct from Aussat, recording the material on one-hour tapes with an overlap between successive tapes. After the required delay has elapsed, the tapes are replayed and fed into the local SBS UHF transmitter. This enables programs to be seen at the same local time in Perth as they are advertised across the rest of the network.

The chain is fully duplicated, so if any drop-out or problems are encountered with the primary machines there is an automatic switch-over to the secondary system, which is so smooth a transition that it is not even noticed by the viewer. In special circumstances, such as live coverage of international soccer, the network can be split and separate programs delivered to all states except WA, so that Perth can catch up to the network and be placed in 'real time'.

The entire network is run from Sydney, the transmitters themselves being remote controlled by codes sent from SBS in their video signal's vertical blanking interval (the same period of the signal used for Teletext). Programs themselves are taken live from the studio, or off 1" videotape.

On-air promos and community service announcements are loaded onto a Beta-

cart machine, and automatically played in program breaks. All station output is driven by Presentation Control and routed through the Master Control Room, the technical heart of SBS. From MCR the signals are piped to a dish atop the station roof, and sent by microwave link to the Belrose Satellite Earth Station for relay to Aussat.

There are actually three dishes on the top of SBS headquarters. One provides the link to Belrose SES, another monitors the Aussat signal itself, while a third receives Soviet television from the Russian satellite *Statsionar 14*, a geostationary bird parked at 96.5° East.

The chain of Statsionar/Gorizont satellites not only services the vast USSR, a region so large that it has 10 different time zones, but also enables their embassies and consulates around the world to tune into programs from the Soviet television service Gosteleradio. By agreement with Gosteleradio, SBS has an exclusive 24-hour direct link to Moscow for Soviet news, current affairs, documentaries and other program material. SBS already screens the Soviet news service 'Vremya' live each weekday at 1200 EST. Items which are relevant or of interest to Australians can be subtitled or voiced-over, for use in the SBS World News and current affairs programs.

Presentation control officer Noel Wilson loads the Betacart for another evening's transmission.

Master Control Room operator Gabor Ziha keeps tabs on the outgoing SBS-TV signal.

Subtitling: SBS pride

No technical dissection of SBS would be complete without an examination of subtitling, which is SBS' entire *raison d'etre*. A team of highly skilled men and women produce English subtitles for programs in more than 40 languages, not just translating words but capturing their meaning, maintaining the integrity and ambience of the original language in every subtitle. This operation, the only one of its kind in the world, uses no small amount of technology in itself.

It begins with each program being viewed and subtitles being written by hand. The viewing tape, a 3/4" U-matic video cassette, includes a 'timecode' – an on-screen time display reading down to 25ths of a second. As each actor starts and stops speaking, the appropriate timecode is noted – these will become the reference points at which subtitles will appear.

Keyboard operators then type the script and timecode references into a PC terminal, and record the finished file on a 3.5" floppy disk. The PCs are fitted with special cards and software developed under the Swedish 'Scantitling' system, in conjunction with SBS. The timecode is then embedded onto a 3/4" working tape as composite video, and viewed with an eye towards corrections and improvements. Any changes are made direct onto the floppy disk file, which is then matched up and married onto the 1" master tape, ready for transmission.

SBS' first 10 years have seen much-publicised turmoil in the commercial broadcasting industry. The famous 'licence to print money' has been revoked, and stations have hit upon hard times. One of the more common moves has been away from large in-house productions which demand high levels of staff, equipment and studio space. The networks now favour a greater number of programs made by outside production companies, and so move towards smaller station premises with lower billings for rent, salaries and capital outlay.

The same 10 years have seen advances in hardware, and the technical

history of SBS charts this course well. Broadcast videotapes have gone from 2″ to 1″ in size, and the requisite size of the machines has also halved. Graphics are now compiled, not using laborious 'cut and paste' methods, but on the computer *Paintbox*.

Electronic news gathering (ENG), once recorded on 3/4″ BVU tape format, has cut across to Betacam SP. ENG cameras now use solid state CCD imaging in place of traditional camera tube lenses – the CCD cameras are smaller, lighter, more robust, consume less power, can film in far lower light levels and do not suffer from flare or burn-out caused by bright lights.

Wherever its stringent budget allows, maintains Madeley, SBS makes use of the latest hardware. "It's fair to say that we do use high-tech equipment. Certainly it is getting smaller and smaller, better and better." Interestingly, he hopes at the same time that SBS will move in the opposite direction to the commercial channels when it comes to the size of the station. "We are certainly looking to improve our accommodation, and perhaps for the first time ever we will have a studio that is a studio, as opposed to a box."

All SBS transmitters now operate in dual-sound, from the stereo test pattern (which features a selection of opera, classical and jazz direct from CD) to programs both in true and simulated stereo. SBS is also looking at applications for dual-language – while this will not replace subtitling, it can be used to offer a choice between languages where a foreign-language narrated documentary or special may be re-narrated in English.

Selling UHF

It was newsreader George Donikian, for years the public face of SBS Television, who re-christened Ultra High Frequency as 'Ultra Hard to Find'. Underscoring the joke was a realisation that SBS' greatest handicap was its position, up on the UHF TV band.

Although the service had started broadcasting on both VHF channel 0 and UHF channel 28 in Sydney and Melbourne, the VHF allocation was only a short-term arrangement through which the public could easily sample multicultural television on their existing TV receivers and aerials. Channel 0 ceased operation on January 5, 1986, and SBS became Australia's first national UHF television network.

In spite of a massive advertising and public education campaign, the first weeks of UHF-only transmission were marked by a flood of calls from frantic former viewers who had 'lost' channel 0, found their VHF aerial inadequate for UHF reception, or simply did not know how to switch over. The selling of UHF had begun.

As new stations are brought on-line and new regions added to the network, SBS mounts local public displays in cooperation with the Department of Transport and Communications. Each operation is staffed by SBS and Departmental representatives, and normally located in major shopping centres for each area. Supported by the Department's toll-free 'UHF Hotline', these campaigns reach thousands of residents and ensure that they get the best out of their new SBS signals.

More importantly, SBS' on-going programming is designed not only to cater for existing viewers, of whom an estimated three million tune in during the course of any given week, but also to attract new viewers to the network, enticing them to invest in a UHF TV aerial. This extends from the popular weekly stable of news and current affairs, movies, documentaries and sport, through to special theme weeks, dedicated to programs on the environment, women, and even the bicentennary of the French Revolution.

SBS continues to search for opportunities to woo potential viewers, and long recognised as 'the soccer station', they saw their best chance yet in the 1990 World Cup.

Simply put and with all hyperbole aside, the World Cup is the world's biggest television sporting spectacle. Soccer teams from around the globe meet every four years to vie for the Cup, cheered on by a cumulative global television audience approaching 15 billion. The 1990 World Cup, held in Italy across June and July, also became the most ambitious project ever undertaken by SBS Television.

SBS invested nearly $3 million in bringing the 1990 World Cup to Australia, with nearly a third of this coming from sponsors Legal & General and Cathay Pacific. Over $1 million worth of the latest in television technology and two and a half tonnes of equipment went into the Cup telecasts. A fully-equipped studio, editing suites and maintenance facilities were designed and constructed for the Cup, dry-run in Sydney and then shipped across to the International Broadcast Centre in Rome.

A team of 28 men and women captured the excitement of the games and the atmosphere of Italy herself, and were linked by satellite to SBS studios in Sydney. The match coverage was given free of charge to the ABC regional network, so that all Australians could enjoy the Cup, and was also sourced to stations in Papua New Guinea, New Zealand and Hong Kong. All 52 matches were televised live, promoted by SBS as the '27 sleepless nights', and the resulting 250 hours of soccer was equivalent to nearly three years of 'Neighbours'!

All of this was bait for a new audience – SBS' greatest-ever sales pitch for UHF, according to Andy Lloyd-James. "The very reason that we bought the World Cup was precisely, one – to remind the audience that many people are missing out on 10 to 12 good hours of entertainment every day, 364-5 days of the year; and two, that actually getting UHF signals isn't necessarily all that hard."

Cornerstone of the campaign was the 'SBS Antenna Hotline', a toll-free telephone service established in conjunction with Hills Industries. The hotline number was featured in all World Cup advertisements and promotions, and provided callers with a one-stop service for arranging purchase and installation of UHF aerials. In its six weeks of operation the SBS Antenna Hotline took over 5000 calls, with many more flowing over to DoTC's UHF Hotline and directly to SBS itself. Manufacturers and retailers reported record-breaking sales of UHF antennas, and installers were kept busy from sun-up to sun-down.

The multi-million dollar gamble paid off handsomely. Ratings for each 24-hour period shot up by 300%, and a nationwide Newspoll survey commissioned by SBS showed that more than 3.2 million Australians watched the grand final.

During the World Cup season an estimated 410,000 people watched SBS-TV for the first time, lured by the soccer. This included 155,000 people who installed a UHF TV antenna specifically for the Cup, and an additional 255,000 tuned their sets and had adequate reception without the need for a UHF aerial. "We're looking at the tip of the iceberg in terms of the potential reach of SBS into Australian homes", says Lloyd-James.

SBS stands ready to take on the new decade.

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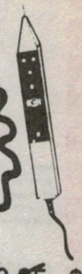

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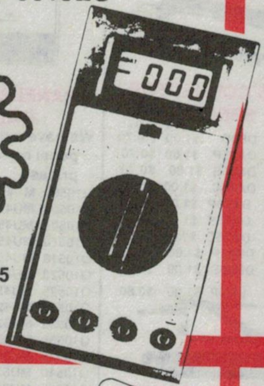

DISPLAY: 3 1/2 DIGIT
BASIC ACCURACY: 0.5% DC
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
COMPACITANCE: 0- 20u[
TRANSISTOR hfe: GAIN OoF -2000oF
CONTINUITY TEST, DIODE TEST

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DIGITAL MULTI METER HC- 3500T

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DC CURRENT: 0- 20A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 20A
RESISTANCE: 0- 20M OHMS
TEMPERATURE: - 20C- 1200C
CONTINUITY TEST, DIODE TEST
TEMPERATURE, CAPACITANCE
FREQUENCY, hfe TEST, DATA HOLD.

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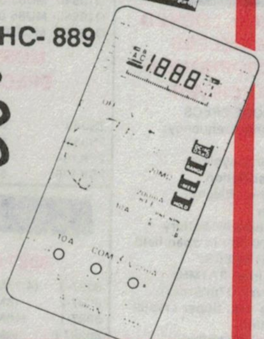

DISPLAY: 3 1/2 DIGIT
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
CONTINUITY TEST, DIODE TEST,
DATA HOLD, TR HFE GAIN,
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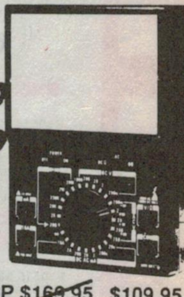

BASIC ACCURACY: 0.5% DC
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
DC AC RMS: -45dB -+50dB
TEMPERATURE: - 20C- 1200C
AC FREQ SPREAD: 50Hz -2KHz
CONTINUITY TEST, DIODE TEST

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DIGITAL MULTI METER HC- 4510

DISPLAY: 4 1/2 DIGIT
BASIC ACCURACY: 0.5% DC V
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
CONTINUITY TEST, DIODE TEST,
DATA HOLD.

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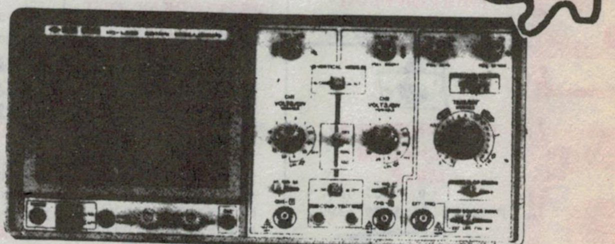

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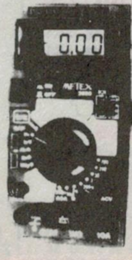

3 1/2 DIGIT 10 AMP
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 700V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
CONTINUITY TEST, DIODE TEST

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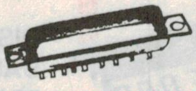

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P10905	DB25S	$1.00	$0.80
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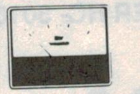

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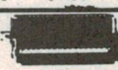

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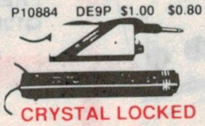


CRYSTAL LOCKED WIRELESS MICROPHONE & RECIEVER

MICROPHONE SPECS:
Transmitting Frequency: 37.1MHz
Transmitting system: Crystal oscillation.
Microphone : Electret condenser
Power supply:9V battery
Range: 300 feet in open field
RECIEVER SPECS:
Receiver freq: 37.1MHz
Output level: 37mV(max)
Receiving sys: Super crystal oscillation
Power sup: 9V battery
Volume control: Tuning Led
Dimmensions:115x32x44mm
Weight: 220grams
A10452..............$99

TOGGLE SWITCHES

		1-9	10-99
S11010	D.P.D.T	$0.90	$0.80
S11020	D.P.D.T	$1.10	$1.00

QUALITY 3MM LEDS

	1-9	10-99	100+
Z10140(R)	...$0.15	$0.12	$0.10
Z10141(G)	....$0.20	$0.25	$0.12
Z10143(Y)	....$0.20	$0.15	$0.12
Z10145(O)	...$0.20	$0.15	$0.12

QUALITY 5MM LEDS

	1-9	10-99	100+
Z10150(R)	$0.15	$0.18	$0.15
Z10151(G)	$0.20	$0.18	$0.15
Z10152(Y)	$0.20	$0.12	$0.15

NICADS

Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

Size	Desc.	1-9	10+	100+
AA	450mAH	$1.95	$1.75	$1.50
C	1 2 A H	$9.95	$9.50	$8.95
D	1 2 A H	$9.95	$9.50	$8.95

MOSFET SPECIALS

	1-9	10+
2SJ49	$7.50	$7.00
2SJ56	$10.00	$9.50
2SK134	$6.90	$6.50
2SK176	$9.50	$8.90

8087 CHIPS

8087-3	(4.77MHZ)	$175
8087-2	(8MHZ)	$245
8087-1	(10MHZ)	$375
80287-6	(6MHZ)	$275
80287-8	(8MHZ)	$375
80287-10	(10MHZ)	$450
80287- 12	(12MHZ)	$675
80387-16	(16MHZ)	$750
80387-20	(20MHZ)	$850
80387-25	(25MHZ)	$995
80387-33	(33MHZ)	$1,495

D TYPE IDC PLUGS

	1-9	10+	100+
· DE9P 9 pin plug P12166	$2.95	$2.50	$2.00
· DA15P 15 pin plug P12168	$3.50	$3.00	$2.50
· DB25P 25 pin plug P12170	$3.95	$3.50	$2.95

D TYPE IDC SOCKETS

	1-9	10+	100+
· DE9S 9 pin socket P12167	$2.95	$2.50	$2.00
· DA15S 15 pin socket P12169	$3.50	$3.00	$2.50
· DB25S 25 pin socket P12171	$3.95	$3.50	$2.95

FLASHING LEDS

red 5mm	1-9	10+
Z10159	$1.10	$1.00

DATA TRANSFER SWITCHES

If you have 2 or 4 compatable devices that need to share a third or fifth, then these inexpencivedata tranfer will save youthe time and hassle of constantly changing cables and leads around.
No power required
Speed and code tranparent
Two or four position rotary switch on front panel.
Switch comes standard with female connector.

RS232- 2 way	$39
RS232- 4 way	$59
RS232- X over	$69
RS232- 2 way auto	$69
Centronics- 2 way	$49
Centronjcs- 4 way	$69
Centronics- X over	$69
Centronics- 2 way auto	$79

MAMMOTH PRICE REDUCTIONS!!!

ECONOMY TRANSFORMERS

	1-9	10+
2155 240V 6-15V 1A Cat M12155	$8.95	$7.95
2156 240V 6-15V A2 Cat M12156	$13.95	$12.95
2840 240V 9VCT Cat M12840	$4.95	$3.95
2851 240V 12-6V CT 250mA CatM12851	$4.95	$4.50
2860 240V 15VCT 250m A Cat M 12860	$4.95	$4.50
6672 240V 15 30vc 1A tapped Cat M16672	$12.95	$11.95

008 335757 TOLL FREE MAIL ORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS AND INQUIRIES CALL (03) 543 7877.

WE HAVE OVER 6,000 ITEMS AVAILABLE!

008 335757 TOLL FREE MAIL ORDER HOTLINE

MICE AT A NICE PRICE

TOUCH MOUSE

A STATIONARY BREAK THROUGH !!!

Now you can use your fingers instead of your mouse.
MODELS: ATM- 110 Touch Mouse for IBM PC/ XT/ AT and compatible's, Operates under Microsoft / mouse system mode.
FEATURES:
- User's finger movements on the 58 X 48mm front panel of the touch mouse control the on- screen cursor movement.
- With no ball, the touch mouse requires no desk space for movement.
- No pad to get dirty and take up desk space.
- One finger can do all the users drawing.
- Compatible with all existing mouse software.
- RS- 232 serial port
- Especially suitable for laptops, the touch mouse saves on desk space.

FREE SOTWARE INCLUDED!

- MOUSE DRIVER
- TEST PROGRAM
- DEMO PROGRAM
- HIGH LEVEL LANGUAGE INTERFACE ROUTINE: Microsoft C, Microsoft Fortran, Quick Basic, Turbo C Pascal ...etc.
- POP-UP MENU

DR. HALO III GRAPHICS SOFTWARE

X19960..$149.00

MICE

FREE MOUSE HOUSE & MOUSE MAT $20 VALUE

INCREDIBLY POPULAR

QUICK MOUSE

MICROSOFT* COMPATIBLE!
- Auto-selection and auto-transfer between mouse system PC mouse ...osoft serial
- Micros... Mouse Systen...
- Super high tracking ..., 600mm sec
- Super high resolution: 200 D P I (0.12mm dot)
- Silicon rubber coated ball
- Optical rotary encoder

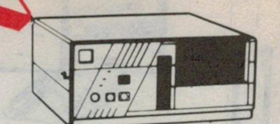
X19952................. $89.00

EVER POPULAR LOW BUDGET WITTY MOUSE

- Three buttons, user definable
- Silicone coated steel ball
- High resolution movement of 195 dots inch. Smaller table space and less hand movement required
- Optical rotary encoder
- Max. tracking speed: 200m sec
- Mouse resident firmware
- Size: 116 x 66 x 34mm
- Mouse Driver Software included, allowing you to install with all popular software packages. Also included is the handy Pop-up menu software that allows the user to integrate the mouse with the keyboard, DOS, and other popular software packages

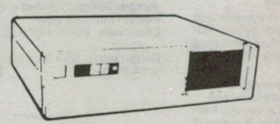
X19950......................$59

COMPUTER CASES



BABY AT* STYLE COMPUTER CASING

Small footprint. Features security key switch, 8 slots and mounting accessories
Size: 360(W) x175(H) x405(D)mm
X11093.......................$99



IBM* XT COMPATIBLE CASE WITH AT* STYLING

Features security key switch, 8 slots, and mounting accessories
Size: 490(W) x 145(H) x 400(D)
X11091.......................$99

HOTLINE
008 33 5757

SUPER BUS MOUSE 2

FREE SOFTWARE

The new Z-NIX Super Bus Mouse 2 allows you to get the most out of your computer and enhance your productivity. It gives you the ability to expand the versitility of your computer through the use of graghic software such as paint, draw and CAD programs. The Super Mouse 2 allows you to run programs like GEM and Windows which makes all operations of the computer easier and faster. Many popular Spreadsheets, databases, word processors and other programs can also be worked with the Super Mouse 2.

- 100% Microsoft Compatible
- IBM or APPLE Family Computer Compatible.
- Free Software with Pop-up Menus.
- Life time Warranty.

Also supplied with the Super Bus Mouse are two FREE Telepaint disks which allows the user to perform high resolution graphics with the mouse.Great Value!
X19951...............................$119

HURRY! THIS OFFER CAN'T LAST

"HANDY"

HS - 3000 HANDY SCANNER

INCLUDES *FREE SOFTWARE!* PC PAINTBRUSH & IMAGE TOOL

- WIDE 4.13" (105mm) scan width
- 100/200/300/400 switchable DPI resolution.

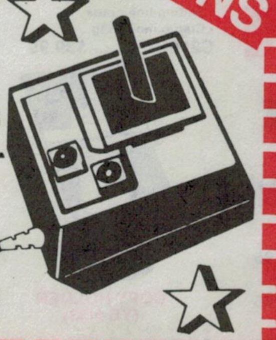
Four encoded modes: B/W and three half tone patterns.
- Thrity-two shades of grey.
- Built-in scanner view window for accurate scanner placement.

X19945..................................$389

"HANDY" AT HALF THE PRICE

BARGAINS

JOYSTICKS



JOYSTICK FOR IBM*

Features selectable "spring centring" or "free floating". Electrical trim adjustments on both axis. 360 degree cursor control
C14205.................$49.95

APPLE* COMPATIBLE JOYSTICK

Ideal for games or word processing. Fits most 6502 "compatible" computers.
C14200................ $29.95

JUST ARRIVED! AGILER SCANNER

FREE.. OCR SOFTWARE

Just arrived! The Agiler Scanner, gives you a professional touch to your printed material. Save time wasted by pasting up artwork. With the Agiler Scanner all your images are on the computer. Algier's self-developed OCR (Optical Character Recognition) software allows you to compile information from newspapers / magazines, books..etc. The data captured can be used by word processing,data-base, desktop publishing and other applications. In addition, Agiler Reader can handle English, German and French

SPECIFICATIONS:
Scanning System: Manual
Reading Width: 105mm+3%
Resolution: 400 DPI standard mode 300/200/100 DPI thinning mode.
Mode selection : Black and white tone, halftone is selected by operating the mode selctor switch
Graduations : 32 graduations
Density: Can be adjusted by the density control VR

EXTRA FEATURES
- IMAGE FILE APPLICATION
- DESKTOP PUBLISHING APPLICATION
- FAX TRANSMISSION APPLICATION
- DR. HALO DPE SOFTWARE INCLUDED. $449

BARGAINS $$$ BARGAINS

RODIRVINGELECTRONICS

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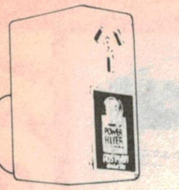


CPF CONTINUOUS POWER FILTER SPIKE ARRESTOR

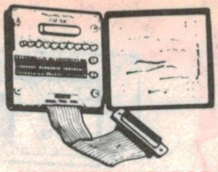
The Fortron CPF Filtered Electronic Spike Protector provides a protective electronic barrier for microcomputers, printers, telephone systems and modems electronic typewriters, audio and stereo systems and other sensitive electronic equipment.

The CPF provides protection from dangerous electrical spikes that can cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life.

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components.

SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spike/RFI Protection: 4,500 amps for 20m/second pulses.
Maximum clamping voltage: 275V differential mode.
Cat.X10088 .... **$69.95**



RS232 BREAK OUT BOX

A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

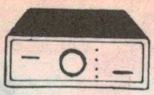
SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket
Indicators: Tricolour LED's for TD RD, RTS, CTS, DSR, CD, TC RC, DTR, (E)TC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm
X15700 .... **$99.95**

THE BUTTON SPIKE PROTECTOR

Surges and spikes are caused not only by lightning strikes and load switching but also by other equipment being switched on and off, such as fluorescent lights, electric motors, fridge freezers, air conditioners, etc.

For effective protection such spikes must be stopped before they reach your equipment. Simply plug The Button into an outlet and it will protect all equipment plugged into adjacent outlets on the same branch circuit. The Button employs unique metal oxide varister technology and will dissipate 150 joules of electrical energy (nearly twice that of comparable surge arresters.)

SPECIFICATIONS:
Voltage 240V Nominal
Total Energy Rating 150 joules
Response Time 10ns
Protection Level 350V peak
.... **$36.95**



2 & 4 WAY RS232 DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY Cat X19120 **only $39**
4 WAY Cat X19125 **only $49**

2 & 4 WAY CENTRONICS DATA TRANSFER SWITCHES

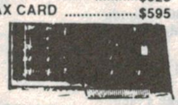
Save time and hassles of constantly changing cables and leads around with these inexpensive data transfer switches. These data switches support the 36 pin centronic interface used by Centronics, Printronics, Data Products, Epson, Micronics, Star, and many other printer manufacturers.

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector
- Bale locks are standard

2 WAY (X19130) **only $49**
4 WAY (X19135) **only $59**

IBM* CARDS

XT HD CONTROLLER $129
AT HD CONTROLLER $199
RS232/ SERIAL/ CLOCK $59
MONO/ COLOUR CARD $96
MULTI I/O $99
512K RAM $59
DIAGNOSTIC $849
TTL/ PRINTER $89
RAM 2M AT EXT/EXP $225
8M AT EXT/EXP $325
FAX CARD $595



4 PORT SERIAL $89
VGA 256K $199
VGA 512K $299
VGA 1MEG $495

VOICE MAIL $245
PRINTER CARD $35
EGA CARD $139
2 WAY FDD CONT. (360K) $49
RS232 SERIAL/ CARD $49
GAMES $29
AT S/P GAMES $35
4 WAY FDD CONT. (360-1.44M) $129
2 WAY FDD CONT. (360-1.44M) $80
CLOCK CARD $49
SMART DRIVE ADAPTER IDE/FDC $89
SMART DRIVE ADAPTER IDE I/O /FDC $119

CENTRONICS GENDER CHANGERS

- Female to Female
- Saves modifying or replacing non-mating Centronics cables
- All 36 pins wired straight through

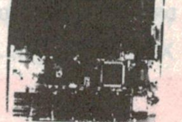
Cat X15663 **Male to Male**
Cat X15661 **Male to Female**
Cat X15664 **Female to Female**
Normally $33.95
Only $24.95

RS232 GENDER CHANGERS

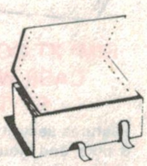
- Saves modifying or replacing non-mating RS232 cables
- All 25 pins wired straight through

Cat X15650 **Male to Male**
Cat X15651 **Male to Female**
Cat X15652 **Female to Female**
Normally $14.95 each
Only $8.95

MOTHERBOARDS

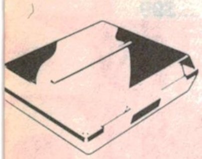


XT 10M MINI $120
XT 31M $199
XT 12M STD. SIZE $199
SUNTEC AT 12M $375
80386-25 ..... $2,695
80386- 33 ..... $2,995



COMPUTER PAPER

Quality paper at a low price! 2,000 sheets of 70 gsm bond paper
Cat C21003 11 x 9½ **$41.00**
Cat C21005 15 x 11 **$67.95**

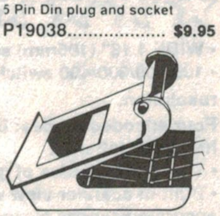


ENCLOSED PRINTER STAND

Transparent cover makes it easy to check on paper supply
Paper can be fed from the centre or the rear according to the design of the printer
Removable drawer which allows paper to be changed without moving the printer
Retractable rear basket makes print-out collection fast and convenient
Suitable for maost printers
C21055 .... **$29.95**

KEYBOARD EXTENSION LEAD

5 Pin Din plug and socket
P19038 .... **$9.95**

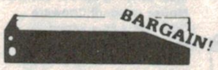


DELUXE PRINTER STAND

- DELUXE PRINTER STAND without occupying extra space.
- Feeds and refolds paper under the printer automatically.
- Adjustable paper deflectors to ensure smooth flow of paper.
- Made of moulded plastic
- Suitable for most printers

C21058 80 column $69.95

RIBBONS



PRINTER RIBBONS TO SUIT:

- CP80, SX80, DP80, BX100, BX100, MB100

	1-9	10+
C22036	$19.95	$17.95

- MX80, FX80, RX80, FX800, MX70, MX80, LX800

	1-9	10+
C22031	$16.95	$15.25

- MX100, FX100, RX100,LQ1000

	1-9	10+
C22002	$19.95	$17.95

- LX80

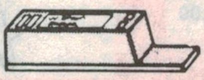
	1-9	10+
C22003	$12.95	$11.95

- C ITOH 8510-1550

	1-9	10+
C22051	$13.95	$12.50

NATIONAL PANASONIC KXM110 PRINTER RIBBON

C22034 .... $19.95



UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less time for less chips)

- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased

Without timer
X14950 .... **$129**
With built-in timer
X14955 .... **$159**

RS232 MINI TESTER

- Male to female connections
- All pin wired straight through
- Dual colour LED indicates activity and direction on 7 lines
- No batteries or power required

T D Transmit Data
D S R Data Set Ready
R D Receive Data
C D Carrier Detect
R T S Request to Send
D T R Data Terminal Ready
C T S Clear to Send
Cat X15656 **Normally $39.95**
SPECIAL. ONLY $32.95

ROD IRVING ELECTRONICS

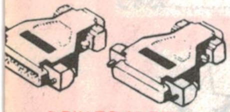
SYDNEY 74 Parramatta Rd
Stanmore 2048
Phone (02) 519 3134
Fax (02) 519 3868

MELBOURNE 48 A Beckett St
Phone (03) 663 6151

NORTHCOTE 425 High St
Phone (03) 489 8866

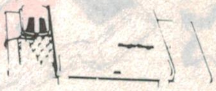
CLAYTON 56 Renver Rd
Phone (03) 543 7877

MAIL ORDER & CORRESPONDENCE
P.O. Box 620, CLAYTON 3168
Order Hotline 008 33 5757
(Toll free, strictly orders only)
Inquiries (03) 543 7877
Telex AA 151938
Fax (03) 543 2648



9 PIN TO 25 PIN CONNECTOR ADAPTORS

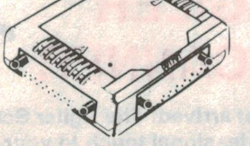
The perfect solution! Features gold plated pins
X15668 DB9 Plug to DB25 Socket
X15669 DB9 Socket to DB25 Plug
each **$8.95**



MAGIC STAGE

A working bench for your Mouse.
- High quality ABS plastic and anti-static rubberised top
- Stationary holder
- Includes pull-out shelf for Mouse
- Dimensions: 280 x 260 x 25mm
- Fits over keyboard

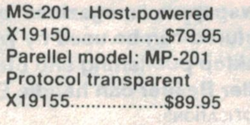
C21080 .... $24.95



POCKET AUTO AB SWITCHES

- Pocket size, auto-scanning
- Allows 2 PCs to share one Printer

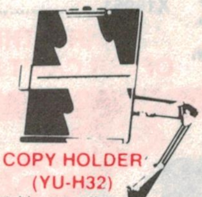
Serial model:
MS-201 - Host-powered
X19150 .... $79.95
Parellel model: MP-201
Protocol transparent
X19155 .... $89.95



DUST COVERS

DUST COVER

Keep your computer and accessories free of dust and grime while not in use
XT* Cover Set
C21066 .... $14.95
AT* Cover Set
C21068 .... $16.95



COPY HOLDER (YU-H32)

- Adjustable arms allows easy positioning
- Copy area 9 1/2" x 11"
- Sliding line guide
- Clamp mounting

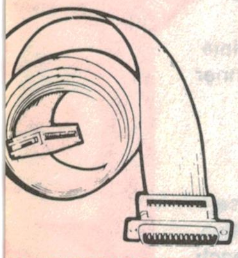
C21062 .... $39.95

MELBOURNE DEALERS
MICRODOT
177 SPRINGVALE ROAD
NUNAWADING. Ph.894 1255

GREENSBOROUGH COMPUTERS
67 GRIMSHAW ST
(cnr Howard st) Ph: 434 6166

BRISBANE DEALER
VRC COMPUTER SERVICE
647 LUTWYCHE RD
LUTWYCHE, 4030

ADELAIDE DEALER
MICROTRONICS
305 MORPHETT ST
ADELAIDE, 5000



5¼" FLOPPY DISK DRIVE EXTENSION CABLE

- IBM* compatible
- DB37 Male to 34 way edge connector
- Length 0.5 metres

P19045 .... $99.95

3½" FLOPPY DISK DRIVE EXTENSION CABLE

- IBM* compatible
- DB37 Male to 34 IDC connector
- Length 0.5 metres

P19046 .... $99.95

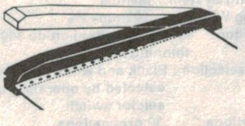
☆☆☆☆☆

SURGE BUSTER

6 PROTECTED POWER OUTLETS
Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc

SPECIFICATIONS:
- Electrical rating: 240V AC, 50Hz, 10A
- 3 x Metal Oxide Varistors (MOV)
- Maximum clamping Voltage: each MOV: 710 volts at 50 amps
- Response time: Less than 25 Nanoseconds.

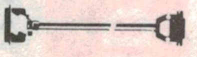
X10086 .... $69.95



RIPPER STRIPPER

Remove ugly paper feed edges quickly and cleanly with this simple little gadget
C21085 .... $14.95

LEADS



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Silicon Valley loses the pillar on which it was built

As reported in our August issue Dr Robert Noyce, founder of Intel Corporation, co-inventor of the integrated circuit and chief executive of the Sematech research consortium, died suddenly at his home in Austin, Texas. Here's a tribute to the man who played an outstanding role in the development of modern semiconductor electronics.

by PAUL SWART

It is often difficult to appreciate the greatness of a particular person until his or her death. Their presence is taken so much for granted, particularly when they are still actively involved in their career. So when they unexpectedly pass away, they leave voids that will never be filled.

Silicon Valley and the rest of the world's electronics industry that was built around Robert Noyce's landmark invention of the integrated circuit will not be the same without him.

Noyce will always be remembered for his co-invention of the integrated circuit, which he and Jack Kilby at Texas Instruments conceived independently of one another 32 years ago.

"I don't think you can exaggerate the impact of the IC on the way we live. It is universal. It is something like the wheel. It is used everywhere," commented John Bardeen, a two-time Nobel prize winner, and himself a co-inventor of the transistor.

"Bob was the guy who started it all in the valley," said National Semiconductor president Charlie Sporck, who worked under Noyce at Fairchild. "There just isn't another Bob Noyce. This is one gap that is not fillable."

Gordon Moore of Intel was deeply saddened by the death of his friend and business partner. "The electronics industry has lost a legendary figure."

"He was a pitcher, a fielder, and a top batter," added Hewlett-Packard president John Young. "It only happens once in a generation that you have a technical innovator and an outstanding business leader. He is going to leave a big hole."

Tinkering in his blood

Bob Noyce was born on December 12 1927, the son of a minister. He began his lifelong involvement in engineering by tinkering endlessly as a boy with broken motors, in the basement of his parents' home in Iowa. Young Noyce loved model airplanes, and later in life, obtained a pilot's licence. He often piloted himself to distant business meetings or to the Sierra Nevadas and Rocky Mountains, where skiing was his great outdoor love.

In high school, Noyce proved a brilliant student, particularly in maths and science subjects. He enrolled in his hometown Grinnell College, where he earned a degree in physics and mathematics.

While in his senior year in 1948, Noyce encountered a device that would command his attention for the next 42 years: the transistor, which had just been invented by three Bell Lab scientists headed by William Shockley.

Noyce's mentor at Grinnell was able to obtain an early sample of the Bell Labs transistor, and Noyce became one of the very first people in the world to conduct experiments with the wondrous device that promised to replace the then industry-standard bulky vacuum tubes.

After Grinnell, Noyce went on to the Massachusetts Institute of Technology, where he graduated in 1954 with a PhD in physical electronics.

At the time, the electronics industry was in the midst of a radical transformation because of the transistor. Noyce was offered lucrative jobs at major companies, including Bell Labs, RCA, and IBM. Instead, Noyce accepted an offer from Philco in Philadelphia, which had just set up a new research centre that focused on the exploration of semiconductors. But Philco, it turned out, was not willing to put up the money to carry out the kind of research Noyce wanted to do.

Then in 1956, transistor inventor William Shockley opened the doors of his Shockley Semiconductor Laboratory in Mountain View. Noyce didn't need a lot of time to decide to move to the West Coast, to join the operation headed by the man he had admired for years.

But for all his technical brilliance, Shockely turned out to be a poor businessman and difficult to work with. So difficult that Noyce and seven other top Shockley engineers tried to make him step aside from the daily operations. When their attempt at mutiny failed, the eight left and formed Fairchild Semiconductor – which opened its doors in 1957 with venture capital from Fairchild Camera and Instruments.

Noyce later conceded that he had been the most reluctant of the 'traitorous eight' as Shockley called the group. Although he had just turned 30, Noyce had already commanded so much respect among his peers that they chose him to be Fairchild's general manager.

In 1959, while working at the Fairchild lab, Noyce hit upon the idea that revolutionised modern society. At the time, engineers had reached a dead end in the design of transistor-based electronic circuits. Circuit designs were outstripping the ability of engineers to make all the necessary connections between the tens of thousands of transistors and other components. The com-

plexity caused new products to be unreliable. And if they did work, they produced too much heat to survive.

Noyce, with his unique background in both transistors and semiconductors, conceived a way of eliminating the cumbersome wiring by etching the transistors onto a single piece of silicon and connecting them by metallic lines.

The same conclusion was reached almost simultaneously by Jack Kilby at Texas Instruments, and both men were recognised by the US Patent office as co-inventors of the integrated circuit.

"Throughout the history of the world, anytime you change by a factor 10 any important technology, you will have either changed the culture or the history of the world. With the IC, we've probably seen a factorof 1 million change in the cost, speed, and function of electronics. That is causing structural change in our society. It is a result of this invention," said Bill Davedow, a venture capitalist and former senior executive under Noyce at Intel.

While this change has been relatively evolutionary in the West, the recent sudden collapse of the communist system – history may well show – was due in large part to the pervasiveness of the integrated circuit which gives individuals such vast powers no repressive government is able to control.

Within less than a decade after Noyce and Kilby's historic discovery, Silicon Valley counted hundreds of start-up firms building ICs, most of them started by former Fairchild executives working under Noyce.

Despite his success at Fairchild, Noyce too got bitten by the Valley's ever-present entrepreneurial bug. In 1968, he left Fairchild along with Gordon Moore to start Intel.

Intel quickly gained a reputation for technological excellence and product innovation. Not surprisingly, it was under Noyce that Intel made what is undeniably its greatest contribution to mankind: the microprocessor.

Since 1974, Noyce had withdrawn himself from the day-to-day operations at Intel. Since then, he increasingly became a spokesman and lobbyist for the US semiconductor industry, culminating in 1988 with his selection as chief executive of Sematech – the five-year, US$1.2 billion joint industry-government venture aimed at providing US chip makers with new manufacturing skills and plant to compete worldwide.

Broad interests

Noyce was a man of many traits. In college, he was a champion diver and remained an active swimmer and skier until his death. He was an active madrigal singer, and "he could beat the stuffing out of anyone in Scrabble," recalls Andy Grove.

Ironically, Noyce had taken a physical test just two weeks before his death. He was proclaimed to be in good health, despite a heavy smoking habit. On Saturday, Noyce played tennis and on Sunday morning, swam a few laps. Minutes later he was stricken by a fatal heart attack, although he had no history of heart problems.

Noyce had an uncommon ability to solve problems – any problems. Recalls Charlie Sporck: "He came to our house years ago in the early days of Fairchild. We were building a brick barbecue and were having problems. Bob proceeded to solve the problem and built the barbecue for us. He had an unbelievable ability to understand a problem and resolve it."

And Noyce was a brilliant manager. Fairchild, most believe, never fully recovered from his departure. Noyce liked to put all of the people who had input on a particular issue in a room and discuss all the pros and cons, then make a decision and implement it.

"You always felt you had your day in court with Bob Noyce. You always felt he was keenly interested in your point of view and took it into consideration in his decision making," said Miller Bonner, manager of communications at Sematech.

Noyce was also a humble man. While he gained fame and fortune, he never sought to promote himself. Instead, he remained a warm, modest and approachable person. Even during his last years at Intel, Noyce often answered his own phone.

Music catalyst

What caused the creative impulse that allowed Bob Noyce to invent the integrated circuit? Apparently his love of music.

Bill Ford, a member of the Robert Noyce's Madrigal Singers in 1959, remembers how Noyce spent a lot of his spare time at Shockley Laboratory making transistors for an electronic organ he was building. Noyce used a time-consuming process for making the transistors, including painting black wax over silicon with a tooth pick.

One evening, after a rehearsal, "Bob expressed his concern about the time required to make all the resistors needed

for the organ. He confided to me the idea that he could save time if he could combine functions and put two transistors onto one chip..."

If Noyce had listened to his marketing and sales executives at Fairchild Semiconductor, that firm would never have exploited Noyce's just invented integrated circuit technology.

Donald Farina, who worked at Fairchild at the time, said that when the company first introduced its first microelectronic circuit in 1960, the sales department strongly opposed the move, saying customers would never buy integrated circuits designed by a semiconductor company. "Only system designers know how to design gates and flip-flops," Farina remembers one sales managers argument.

The sales department had its eyes set on the 'Esaki diode', which was fascinating the electronics industry at the time. They asked Noyce to shelve the IC for the time being in favour of the Esaki diode.

"But Noyce rejected the majority view. He trusted his insight and stuck to his convictions that ICs must be Fairchild's future."

Venture capitalist Tom Skornia remembers dealing with Noyce on several investment issues. In the spring of 1969, Skornia was busy helping put Advanced Micro Devices on its financial feet. He showed Noyce the business plan, and Noyce was immediately interested because he knew two of AMD's key founders, Jerry Sanders and Ed Turney. They had been the two super gurus of Fairchild's marketing and sales departments.

Because of their background, Noyce assumed the two were merely going to set up a chip distribution company. Then his eye caught the 'Manufacturing Section' of the business plan.

"You mean they're actually going to try to make these things?" Skornia remembers Noyce saying in amazement.

Noyce did buy a small stake in AMD, and later told Skornia that "Sanders and his guys have done a good job."

But Noyce also had the opportunity to invest in Apple computer, when his wife Ann Bowers brought him a venture capital proposal for Apple.

Noyce told his wife he wasn't interested, as no one had yet shown the likelihood of a significant market for personal computers.

Later Noyce often used the incident to state that "How can government be expected to make sound decisions when someone like me, with a lifetime in the electronics industry, is capable of making such a mistake."

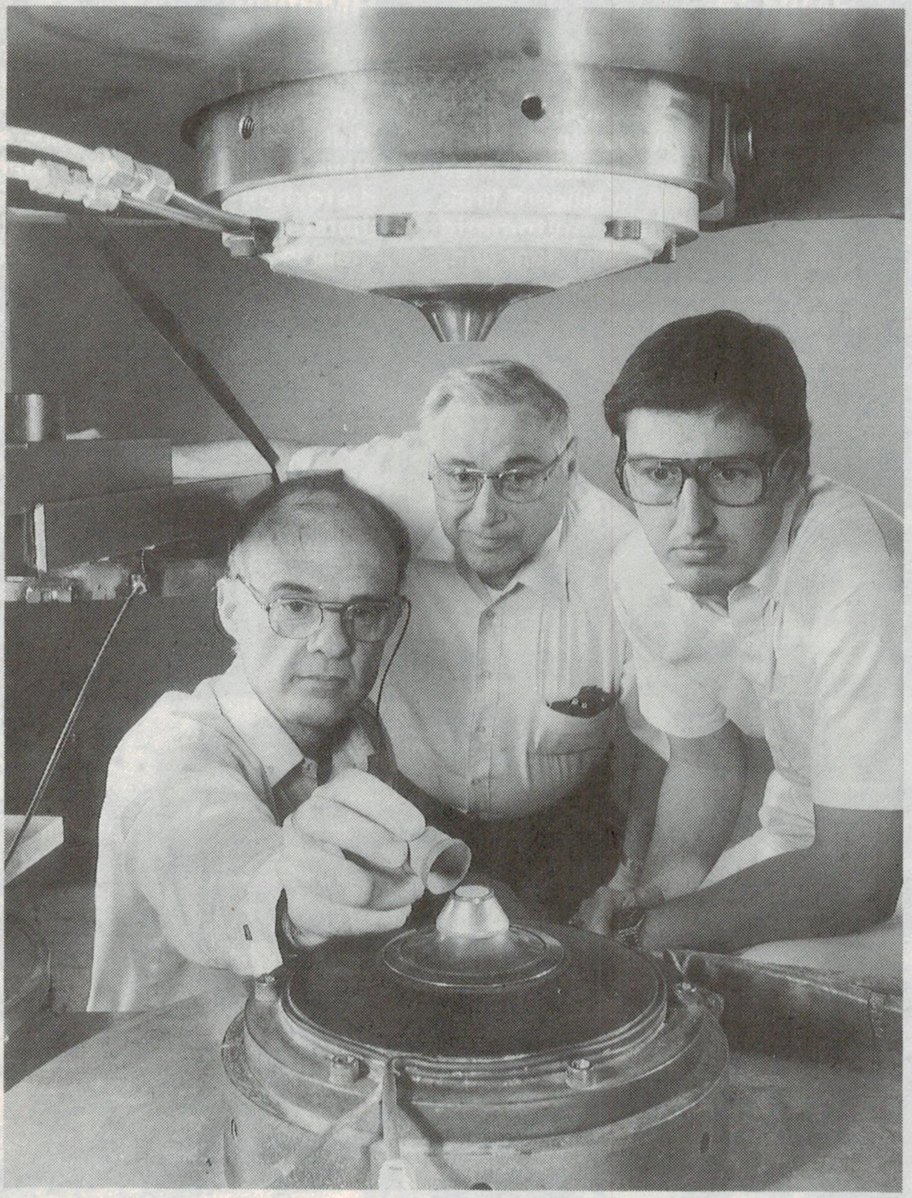
Noyce was also the pioneer of a management style that has almost become standard in Silicon Valley. Where East Coast executives tend to separate themselves in their organisation, in plush offices secured with huge mahogany doors, Noyce, along with Bill Hewlett and David Packard before him, set all of the previous management models aside and built on trust in his employees and their capabilities.

Noyce, as part of that style, was one of the pioneers of the 'open office' concept, in which both upper and lower-level managers and their respective staff are separated only by five-foot cubicle divider walls. In Silicon Valley and around the world, this has become the standard in workplace design.

Now an unscalable divider wall has separated Noyce from our world, and Silicon Valley's semiconductor industry has lost the pillars on which it was built. Life and the chip business will not be the same for it. EA

NEWS HIGHLIGHTS

GE MAKES PURER, BETTER CONDUCTING DIAMONDS



By combining two radically different approaches to diamond-making, GE scientists in New York have grown gem-quality crystals with unexpected and previously unattainable physical properties – including the ability to function as by far the world's best conductors of heat.

At room temperature, these 'isotopically-pure' crystals can conduct heat up to 50% more efficiently than natural diamond – the material that, until now, has reigned as the unchallenged heat-transmission champion. Compared with copper, the crystals are 850% more efficient at carrying away heat. In addition, they are 1000% more resistant to damage from high-power lasers than naturally mined diamonds.

Dr Walter L.Robb, GE senior vice president for corporate research and development, said "The secret to the unparalleled heat-transfer performance of these unique crystals is that they contain almost none of the Carbon-13 isotope that subtracts from natural diamond's heat-transfer properties."

Diamonds consist basically of two isotopes of carbon, Carbon-12 and Carbon-13, the GE research director explained. The Carbon-13 is an impurity that slows heat transmission, even though it occurs in only small amounts in natural crystals. The best natural diamond heat conductors are comprised of 99% Carbon-12. In GE's special crystals, by contrast, the Carbon-12 concentration exceeds 99.9%.

Dr Robb pointed out that the only way to produce these isotopically-pure crystals is by a proprietary two-step process invented by GE scientists. It combines the oldest method of diamond-making – the high pressure process – with the newest – the chemical vapour deposition process, he added.

Sliced into thin heat sinks, the new diamond material promises to give manufacturers of telecommunications systems, computers, and integrated circuit chips a vastly improved way to shed heat. For example, it will provide a means for dissipating the large amounts of potentially damaging heat produced when integrated circuit chips are mounted densely together.

In addition, isotopically-pure diamond crystals are expected to open new design frontiers for manufacturers of high-power lasers, used in a range of applications from welding operations to drilling holes in tough superalloys. The crystals are much less susceptible to laser damage than any other known transparent material – making them ideal for laser mirrors and windows.

The unexcelled performance of these isotopically-pure crystals came as a surprise even to their inventors. A long-established scientific theory regarding thermal conductivity predicted that, at best, these special gem-quality diamonds should be only fractionally better heat transmitters than natural diamonds at room temperature.

"It's as if you went into a high-jump competition hoping to slightly beat the world's record by going a few inches over eight feet – and came away with a high jump of 12 feet," Dr Robb said.

FIRMS SHOULD PREPARE FOR STAFF TRAINING, SAYS STOTT'S COLLEGE EXPERT

The Training Guarantee Act went into operation on July 1 this year, and since then all Australian employers with a payroll over $200,000 pa must spend at least 1% of that figure on staff training (tax deductible) – or pay the same figure as a non-deductible tax levy. Firms in this position should therefore be setting up realistic training schemes, and preferably in conjunction with established training organisations, according to training consultant Margaret Campion of Australian-owned and operated Stott's Correspondence College.

Established in Melbourne in 1884, Stott's has branches in all states and overseas. It offers a wide range of some 200 structured work-related courses, all studied in external or off-campus mode. Ms Campion points out that this makes the courses very flexible in terms of timing, and does not involve the cost or inconvenience of sending employees offsite to classes or seminars.

Stott's also offers a course for company Education and Training Officers, and Ms Campion suggests that enrolling a suitable employee in this course is a sensible 'first step' by companies in setting up a cost-effective training scheme. The College can be contacted by circling 203 on our Reader Service Coupon, or at 140 Flinders Street, Melbourne 3000; phone (03) 654 6211.

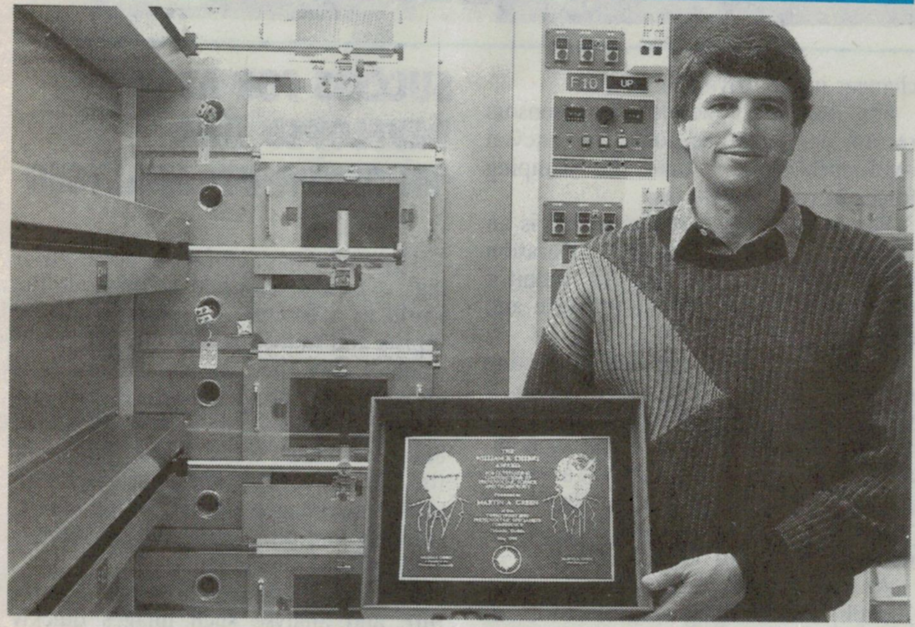
IAEA TO VIEW AUSTRALIAN VIDEO LINK

The Australian Nuclear Science Technology Organisation (ANSTO) will, as a result of a request from the International Atomic Energy Agency (IAEA) in Vienna, demonstrate a new Australian-developed surveillance device for nuclear facilities.

The device consists of a remote unattended video camera system at ANSTO's Hifar reactor, which when alarm activated will transmit video pictures to receiving stations in Canberra and Vienna using ordinary telephone lines. The video transmissions may be initiated from either the camera detection unit at ANSTO or from either receiving station.

The system selected for this demonstration is a Zone Intelligent Digital Video System developed in Australia, and marketed by Zone Technology of Rosehill NSW.

Patented in 39 countries, the Zone IDV system is an integrated security system based around a low cost microprocessor-controlled video camera. Circuitry in the camera includes: frame/grab/store; analog-to-digital conversion; four sector alarm panel; time/date/location image imprint; analog video sequencer; and a 9600bps cryptographic modem.



UNSW RESEARCHER WINS IEEE AWARD

Professor Martin Green, recently elected to the Australian Academy of Science, has been further honoured with the William R.Cherry award by the US Institute of Electrical and Electronic Engineers (IEEE).

Professor Green, Head of the University of NSW Solar Photovoltaic Laboratory, received the award at the latest IEEE Photovoltaic Specialists Conference in Orlando, Florida, in June and is the first non-US citizen to receive it.

The award was instituted in honour of the late William Cherry, a US scientist who pioneered the use of photovoltaics on spacecraft and later for terrestrial purposes.

The award was nicely timed. At the IEEE conference, Professor Green and his 'solar lab' team announced that they had lifted the efficiency of a silicon solar cell to 24.2% in unconcentrated light – thus continuing the group's world dominance of silicon solar cell efficiency for the past seven years.

The group also holds the record for space-borne silicon cells, 20.8%, although 'exotics' such as gallium arsenide or indium phosphide cells – costing between 30 and 100 times as much as silicon cells – are attracting interest as high performance cells in spacecraft, where weight is a greater consideration than cost.

Professor Green said the William Cherry award was a tribute to the work of the whole photovoltaics group at UNSW.

CSA DEVELOPS WARFARE SOFTWARE

Computer Sciences of Australia has developed a realtime software system that enables the Australian Army to use computers loaded on trucks to intercept and record radio messages transmitted by an aggressor.

The system, Communications Electronic Support Measures (Comms ESM), also pinpoints enemy transmitters for targetting.

An essential part of the Army's electronic warfare programme, Comms ESM runs on computers modified and strengthened to military standards and able to operate at temperatures ranging from –40° to +50°C.

CSA's initial software contract with Sanders Associates, the prime contractor, was worth $1.6 million. A team of CSA software engineers worked on the project in the United States and Australia, after having cooperated with Sanders on a project definition study. The Army has since awarded CSA a contract to maintain the Comms ESM software.

NEWS HIGHLIGHTS

WINNER OF ICOM R-9000 RECEIVER

The lucky *Electronics Australia* subscriber to win our Subscription Promotion for March-June 1990 was Mr C.Merrell, of Mt Waverley in Melbourne. Mr Merrell is now the delighted owner of a fantastic Icom IC-9000 top-of-the-line communications receiver, as reviewed by our editor in the March 1990 issue, and valued at $7700.

Pictured is Mr Merrell (centre) being presented with his R9000 by Mr Kiyoshi Fukushima, managing director of Icom Australia, watched by *EA's* Melbourne representative Nikki Roche.

VDO DEVELOPS ACTIVE SUSPENSION SYSTEM

Melbourne-based electronic component manufacturer VDO has developed an active suspension system it claims will offer drivers greater safety, a better ride and improved vehicle performance.

The VDO system combines electronically regulated variable suspension and integrated levelling operations, and is claimed to provide safe, comfortable motoring – even at high speeds.

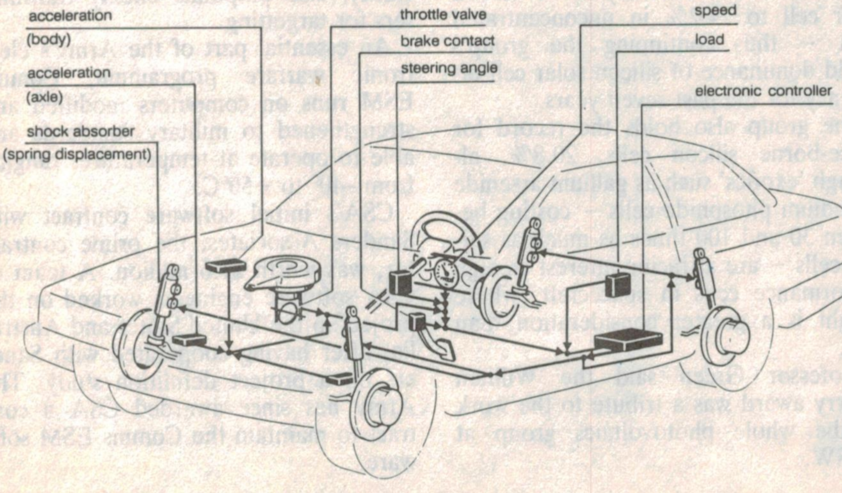
Conventional suspension systems can never be anything but a compromise because their characteristics cannot be altered while driving. But the VDO electronic ride control system uses a number of sensors to detect changes in the dynamic state of a vehicle. The sensors continuously monitor speed, acceleration and steering angle so the suspension can adapt immediately to any changes in the driving situation.

For example, acceleration sensors record car body response to uneven road surfaces and tune the damping forces to road conditions.

The second phase of the system is an integrated levelling control operation which also uses sensors to monitor throttle valve angle, brake pressure and speed.

If the electronics module detecting normal forces are exceeded when a vehicle begins to go around a curve, the valves on the shock absorbers immediately shift the suspension to a stiffer position. The switch from 'soft' to 'hard', required for the sake of stability, occurs within 20 to 30 milliseconds.

At relatively high speeds, say over 100kph, the levelling control automatically lowers the vehicle body by 30 to 40mm. This action improves the vehicle's centre of gravity and drops the drag co-efficient considerably.



SUCCESS FOR AUST. DEVELOPED DNA 'FINGERPRINT' ANALYSER

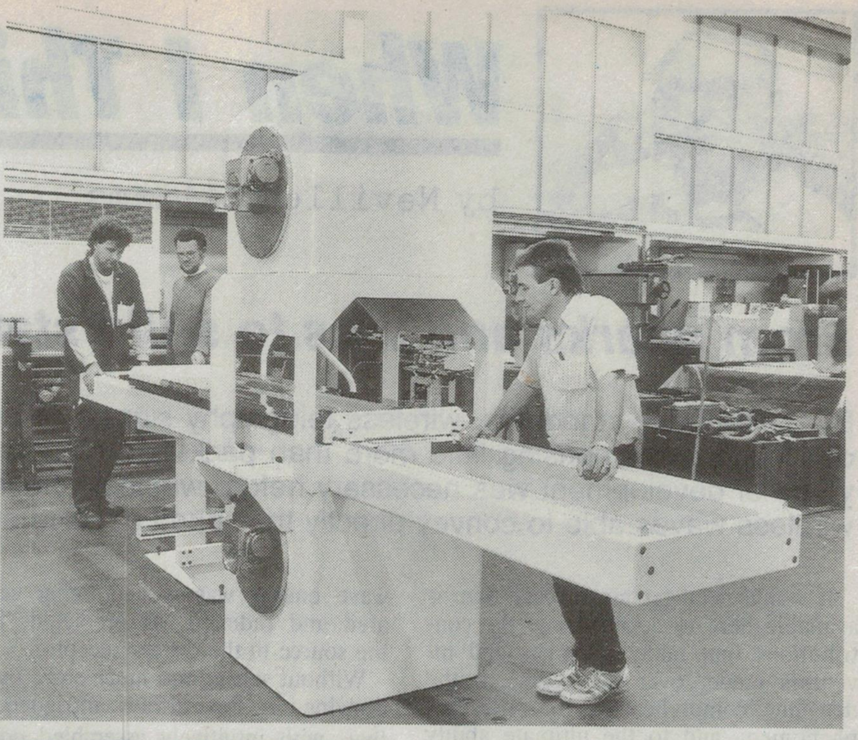
The technique of DNA 'fingerprinting' is now established throughout the world as a forensic tool for identifying rapists and murderers, from small quantities of skin, hair or body fluids. It is also used for providing evidence in paternity disputes, for genetic diagnosis and to establish racial origins. However the technique has been criticised because the images produced are blurry, complex and difficult to analyse reliably with even a trained eye.

But a PC-based system which can capture and analyse such images quickly and accurately has now been developed by Australian firm Forensic Science Technology International (FSTI), part of the Vision Systems Group based at Adelaide's Technology Park, in South Australia.

The FSTI 'Tracktel' system uses a high-resolution video camera to capture an image of the electrophoresis plate on which the DNA 'fingerprint' appears. Software running on a PC then analyses the image and stores its results in a database for comparison. A system costs around $40,000, making it suitable for both forensic research laboratories and hospital pathology labs.

FSTI has installed Tracktel systems in most capital cities, and is in the process of establishing international markets for the system. Currently there do not appear to be any major competitors.

ANSTO PROTEIN MONITOR SOLD TO UNI OF TEXAS



The first commercial Total Body Protein Monitor (TBPM) built by the Australian Nuclear Science Technology Organisation (ANSTO) is being delivered to the University of Texas. It cost $200,000 and will be used in the study of obese patients.

The TBPM was developed by ANSTO and its commercial partner, Canberra Industries, and built in ANSTO's workshops at Lucas Heights following work undertaken with a prototype machine now installed at the Royal North Shore Hospital, Sydney.

"The TBPM is designed specificially to detect the level of nitrogen in the body," Dr Barry Allen, the project manager said.

We know that the presence or lack of nitrogen is an indicator of healthy tissue. The scans we make with the TBPM can assist physicians in locating diseased or unhealthy organs, he said.

"The machine at Royal North Short has also been used to assess the post-operative progress of patients and some very interesting research on cystic fibrosis, a disease which kills many of its victims. Protein retention in HIV-positive patients has also been carried out."

"ANSTO designed the table and hardware for the machine and Canberra Industries provided the computer equipment. The software to run the machine was developed by computer scientists at Lucas Heights," added Dr Allen.

NEWS BRIEFS

- ***Plessey Semiconductors*** has become a part of ***GEC Components***, and is now based at 2 Giffnock Avenue, North Ryde, 2113. The new phone number is (02) 887 6222, fax (02) 805 0272. The division's product range has been expanded, and now includes Inmos transputers and SGS Thomson semiconductors.
- The new head of Australian operations for ***Philips Industries*** is Mr Just Veeneklaas, who was designated to become managing director on September 1. Mr Veeneklaas will also become chairman in January 1991, upon the planned retirement of Mr MacLaine Pont.
- Test instrument and computer maker ***Hewlett-Packard Australia*** has opened a new 'state of the art' sales office in the Melbourne suburb of Abbotsford. The new office features include ISDN networking, service access floors and a 100-seat auditorium.
- US-based diode and rectifier maker BKC International Electronics has appointed ***Crusader Electronic Components*** as its exclusive agent in Australia and New Zealand. BKC is the world's largest manufacturer of germanium diodes, and also makes silicon switching, zener and Schottky diodes.
- ***NEC Australia*** has a new managing director: Mr Aiji Harada, who replaces Mr Theo Sugihara. Mr Harada has been vice president of NEC America since 1987, and is an acknowledged authority on microwave communication systems.
- The high power switching power supplies of Santa Monica-based Pioneer Magnetics Inc. are now available from ***Amtex Electronics***, which has been appointed the firm's exclusive Australian distributor. Pioneer holds over 40 patents for switching power supplies, and its 'International' line includes modes with ratings from 250W to 2kW.
- Mr Clive Muir has been appointed Victorian state manager for ***Acme Electronics*** a division of Hardie Technologies. Mr Muir has held senior management positions with GMH, Siemens and ANZ Banking Group.
- Latest company to join the Australian Government's Partnerships for Development Program is ***Fujitsu Limited***, said to be Japan's largest computer and communications equipment maker. Over the next seven years the firm has undertaken to spend $117 million in local R&D, and to achieve more than $500 million in export sales.
- ***IREECON '91*** will be held at the Sydney Convention Centre, Darling Harbour from September 17-20, 1991. The IREE is offering a sliding scale discount for exhibitors who book before May 8; enquiries to (02) 327 4822.
- Mr M.Keskin has been appointed digital product manager for Sydney-based ***RF Devices***, which is to manufacture switch-made power supplies under licence to Powertran of the UK.

When I Think Back...

by Neville Williams

From sparks and arcs to solid state – part 1

By present-day standards, wireless telegraphy signals at the turn of the century could be fairly described as comprising little more than packaged man-made electrical noise. A further 10-15 years of development was necessary before wireless telephony became really practicable, with wireless waves able to convey directly the sound of voice and music.

It would need far more space than is available here to acknowledge the contributions that many scientists and inventors made, over the years, to the dawning comprehension of electrical phenomena and to the ultimate ability to communicate over a distance by electrical signals.

Historically, however, landline telegraphy became a reality, around 1840, due largely to the work of Samuel Finley Breese Morse, better known for the telegraphic code that bears his name. Landline *telephony* – the 'speaking telephone' – followed in 1876, thanks mainly to Alexander Graham Bell.

'Wireless' communication, in turn, owes much to a landmark experiment performed by the German physicist Heinrich Hertz in 1888 at the Karlsruhe Polytechnic. Ironically, Hertz did not have communication in mind at the time. Rather, as a dedicated academic and at the suggestion of the famous Hermann Helmholtz, he was seeking to verify the existance and behaviour of electromagnetic waves. Said to resemble light waves, they had been predicted by the brilliant mathematician Professor James Clerk Maxwell 25 years earlier.

An old-style artist's drawing in *The Electronic Revolution* (S. Handel, Pelican, 1967) depicts Hertz at a laboratory table using a hand driven magneto-like generator to create a sequence of discharges across a spark-gap separating two vertical metal rods, each one surmounted by a metal ring 30cm or so in diameter.

On another bench, at the far end of the laboratory is a similar rod and ring with a minute gap at the top. Each time a discharge was produced at the source, a spark occurred at the distant spark gap, suggesting that electromagnetic wave energy was indeed being generated and radiated, as predicted, from the source to the distant receptor.

Without setting too much store by the drawing, it has always intrigued me that, with intuitively assembled equipment, the energy level created and intercepted by Hertz was sufficient to produce a plainly visible spark.

In other days, as an amateur radio operator, I did my share of electronic 'plumbing', building UHF transmitters and receivers with tubular metal *Lecher* lines – but they were cut to very precise lengths, calculated by time-proven formulas. And, at the end of the day, I had access to signal detection equipment far more sensitive than a spark gap in an open loop!

Skill plus good luck

How Hertz arrived at the shape and dimensions for his historic spark 'transmitter' and 'receiver' is open to speculation but, in his recent article in *EA* on 'Syntony and Spark', Peter Jensen suggests that it was by a combination of undoubted scientific skill and sheer good luck.

Hertz' laboratory 'transmissions' have been variously reported as being on a wavelength between about one metre and a couple of centimetres. This would put them in the frequency range 300 to 15,000MHz, where they would indeed have behaved more like light waves than a signal of signficantly greater wavelength or lower frequency.

Moreover, by using a transmitter and a receptor of comparable physical dimensions, he would more likely have satisfied the need for a common resonant frequency – a requirement that was not formally demonstrated and documented until 1894, by Sir Oliver Lodge. Lodge referred to it as 'syntony', a term that has long since been displaced by 'resonance' or 'tuning'.

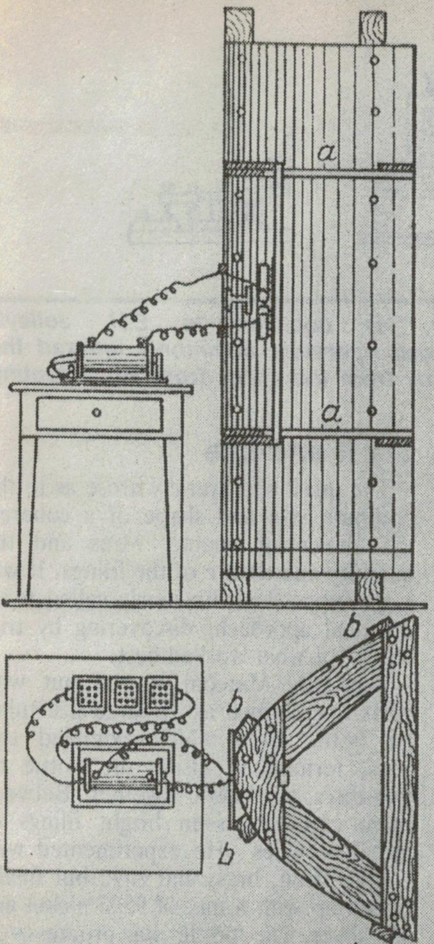
Curiously, research into wireless communication was not universally applauded by the scientific establishment of the day – as evidenced by the reaction of Lord Kelvin, who reportedly once remarked: "Wireless is all very well but I'd rather send a message by a boy on a pony!"

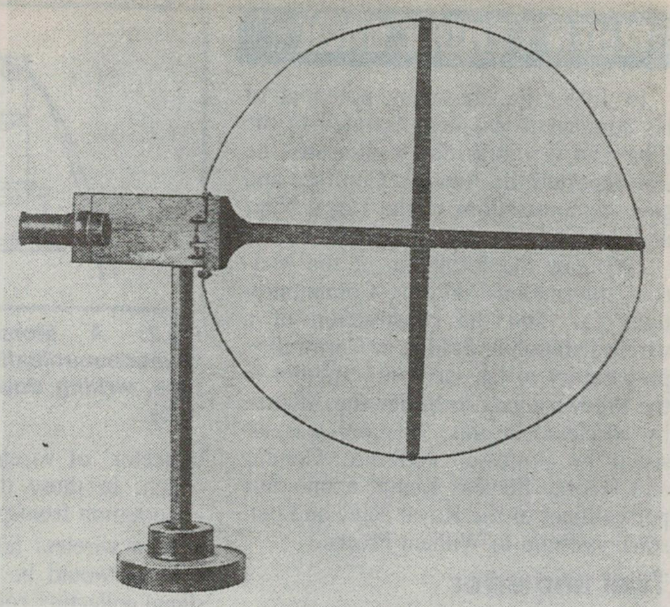
David Edward Hughes was an early victim of just such scientific scepticism. Born in London in 1831, he was raised in Virginia and became professor of music at Bardstown College, Kentucky. Fascinated by electrical communication, however, he is credited with having developed a telegraph printer in 1854-5 and a special microphone some years later.

In 1879, back in London and nine years ahead of Hertz, he set out to investigate what he described as the 'aerial' transmission of electromagnetic waves. Using simple handyman materials, he set up a primitive spark transmitter in one room of his home in Portland St, which was pulsed on and off automatically by a clockwork-driven switch.

What he used as a receiver is unclear, other than that it was apparently contrived around some sort of coherer, plus a transducer of his own design. In fact, the combination worked so well that it sensed the transmitter pulses, not just inside the house, but in the street outside over a distance of some 500 metres.

Encouraged by the results, Professor Hughes demonstrated them to the President of the Royal Society – of which he was a fellow – a Mr Spottiswood and to two secretaries, Professors Huxley and Sir George Stokes, in early 1880. While





Above: Hertz's receiver was a simple loop antenna with a tiny spark gap, viewed via a microscope.

Left: One of Hertz's early transmitting setups, with what amounts to a vertical dipole about 300mm long in a parabolic reflector.

seemingly impressed, they nevertheless refused to recommend an official presentation to the Society, on the grounds that what they had seen could have been due to ordinary magnetic induction: a captive magnetic field from one conductor inducing current in another conductor close by. They would simply not accept the notion of electromagnetic energy being launched, wave-like, into space.

Hughes was so discouraged by their rejection that he refused even to write a paper for the Society detailing his work, and it might have remained unknown had it not been for Sir William Crookes.

Age of wireless

Notable amongst other things for his pioneering work in the area of cathode-ray and X-ray tubes, Crookes was one establishment figure who foresaw the possibility of a totally new method of communication using Hughes' 'aerial' waves, or what later came to be known as 'Hertzian' waves. Other historic figures who clearly had a similar vision, including:

- Aleksandr Popov, the Russian pioneer, who mentioned the possibility of wireless telegraphy in his notes, even though he was primarily concerned with researching electrical storm phenomena.
- Mahlon Loomis, who was granted what may well qualify as the first US patent for 'aerial telegraphy' in July 1872, with a practical demonstration following in 1886.
- Professor Amos E.Tolbear of Tufts College, who sent and received electric impulses using gilt kites tethered by metal wires, as described in a *Scientfic American* supplement dated December 11, 1896.
- Nicola Tesla, a Croation scientist who emigrated to the USA and looked beyond mere communication in a book published in 1904, to 'education of the masses' (by wireless) in uncivilised countries.
- Sir Oliver Lodge, who in Britain closely studied the work of Hertz and devised a practical receiver and inker to receive and display Hertzian signals.
- Alan Campbell-Swinton, an early TV visionary, who commended the innovative young emigrant Marconi to William Preece, Chief of the Engineering Department of the British Post Office.
- Sir William Preece, who had long been seeking better means of warning lightships and lighthouses of impending storms. He subsequently gave 'warm' official support to Marconi.
- Sir Henry Jackson, belatedly credited with introducing wireless signalling between ships of the British Navy – under a predictable veil of secrecy!

There were many others, but Guglielmo Marconi proved, far and away, to be the dominating figure in the history of wireless communication. Born in Italy in 1874 of Italian/Irish parents, he emigrated to London in 1896 and began immediately to pursue his youthful committment to the technology.

Although not academically qualified, he was an outstanding innovator and entrepreneur, with the ability and the will to develop and apply his own and other people's ideas to projects for which most others were limited to conjecture.

With the backing of Sir William Preece, he installed a functional transmitter on the Isle of Wight in 1897, at Bournemouth/Poole in 1898 and, in that same year reported by wireless the results of the Kingstown regatta.

In 1889, the life-saving potential of his equipment was demonstrated in the *Elba* and *Goodwin Sands* disasters; he also reported the America Cup race and gave demonstrations to the Royal Navy and the US Navy and Army.

1900 saw the formation of the Marconi International Marine Communications Co, and the construction of a wireless station at Poldhu in Cornwall – preparatory to his successful attempt in the following year to bridge the Atlantic by wireless. In this, Marconi was assisted by Professor Ambrose Fleming and George Stevens Kemp, a one-time petty officer of the Royal Navy and personal assistant to William Preece.

Trial and error

The evolution of wireless components and technology during these formative years was very much a process of trial and error; of pursuing ideas and hunches to see if they worked, with the explanatory theory emerging later. The development of the 'coherer' was a case in point.

In 1835, a scientist named Munk, about whom little else is known, observed that the electrical resistance of a small pile of metal filings was mysteriously reduced by the discharge nearby of a Leyden jar – an early form of capacitor.

It seemed a pointless bit of scientific trivia until Professor Edouard Branly, of the Catholic University in Paris, poured some filings into a glass tube accessed by two separate contact wires and noted that the particles would clump together or 'cohere' if exposed to a pulse of RF energy. In the process, Munk's pointless pile of metal filings had been transformed into a possible 'detector' of wireless waves – a term which, in those days, had a different connotation from present usage.

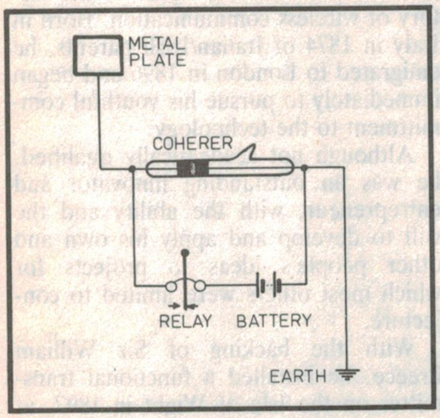


Fig.1: An early Marconi receiver, using his sealed coherer with a parallel battery/relay circuit.

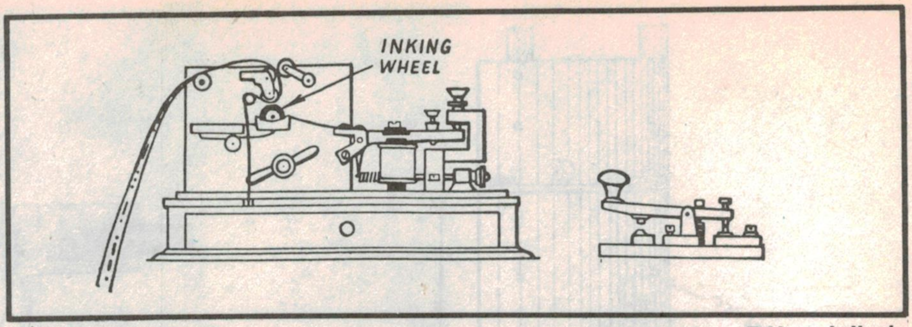


Fig.2: A Morse inker and key, as depicted in E.H. Jolley's 'Telecommunications' (1962). Experienced operators commonly ignored the tape, writing down the message directly from the clicks from the actuating relay.

In a wireless telegraph receiver, the coherer would be so connected to the signal collecting components that incoming RF pulses would be applied across the two connecting wires. As well, a battery and a galvanometer or other current sensing devices would also be connected across the coherer (See Fig.1, also the panel on page 37 of *EA* November 1989).

In the standby condition, awaiting an incoming signal, the particles would be loose in the container; their resistance would be relatively high and the galvanometer deflection quite small. With the arrival of an RF signal pulse, the particles would clump together or cohere; their effective resistance would be lowered and the galvanometer would register a significantly higher reading.

In short, the coherer did not operate as a rectifier/detector in the present-day sense of the term but, rather, as a signal sensitive switch or resistor – able to control the current through an external indicating circuit. As such, it could initiate a reading on a galvanometer in the presence of a signal, cause an audible click in a pair of headphones or operate a relay controlling a Morse code inked-paper recorder (Fig.2).

In its simplest form, the coherer needed to be tapped immediately afterwards, to de-cohere the particles and prepare the receiver for the next pulse – a tedious procedure which Branly, Lodge, Popov and Marconi obviated more or less independently by providing their coherers with an automatic, magnetically operated self-tapper.

It didn't take them long to realise that the self-tapper could, as easily, take the form of an electric buzzer or bell, serving both to vibrate the particles and to produce a recognisable sound with each RF signal pulse.

Try it and see

The question naturally arose as to the optimum size and shape of a coherer, the choice of contact wires and the quantity and nature of the filings. It was a question which obviously called for a practical approach: discovering by trial and error what worked best.

Typically, Marconi started out with what is described as: 'a large-size tubular bottle from which extended two rods, terminated inside the bottle on two discs, very close together. Between them could be seen bright filings or metal particles'. He experimented with copper, iron, brass and zinc, but finally ended up with a mix of 95% nickel and 5% silver. The 'bottle' was progressively reduced in size to a short piece of glass tube, with the leads inserted in a way that allowed the device to be evacuated and sealed (Fig.1).

Fitted with an automatic de-coherer, Marconi's miniature coherer worked so well that any uncertainty he might have had about the merit of his experiments vanished. To quote from his notes:

Every time I sent a train of electric waves, the clapper touched the tube and so restored the detector at once to its pristine state of sensibility. It was precisely at this moment that I thought for the first time of transmitting telegraphic signals and of substituting a Morse machine for the voltmeter.

While the coherer was probably the most widely used device in the 1890s for sensing the presence of RF signals, strenuous efforts were made to develop alternative types of signal detector, partly to avoid patent licensing fees and partly in a search for improved sensitivity and reliability. One such was Marconi's own magnetic detector. (See *EA* for November/December 1989).

The detection of incoming signals was, of course, an essential aspect of early wireless communication but, rather than pursue the subject in what is

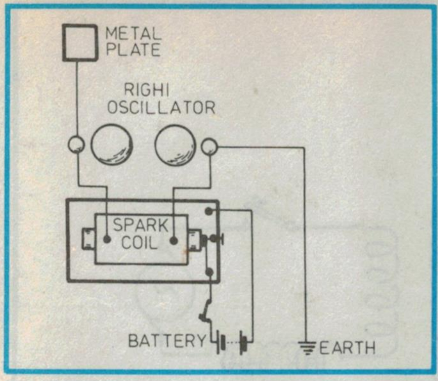


Fig.3: An early Marconi spark transmitter. The Morse key was in series with the battery.

essentially a survey of transmitting techniques, it may be better to devote a separate article to receivers generally and detectors in particular.

Structured noise

Fig.3 illustrates the basic transmitter technology which Marconi inherited informally from Professor Righi of Bologna University and took with him to Britain in 1896. Central to it was a spark coil with separate primary and secondary windings – a version of what we might these days describe as an electric buzzer.

When the unit was activated by depressing a Morse key in the battery circuit, current would flow through the primary winding of the spark coil, magnetising the iron core and attracting to it a spring-mounted vane. In moving towards the core, however, the vane would open a pair of contacts and interrupt the magnetising current, allowing it to flip back to its original position.

In moving to and fro – 'buzzing' or 'trembling' – the vane would thus make and break the current through the primary winding, causing a rapid sequential build-up and collapse of the magnetic field. This, in turn, would induce a corresponding sequence of high voltage pulses, or spikes, across a secondary winding wound with a large number of turns of fine gauge wire.

One side of the secondary winding is shown connected to earth, the other to a vertical rod supporting a metal plate. Between the connections are two metal balls, normally supported on threaded metal rods and capable of being adjusted so that the gap between them can be made small enough for a spark to occur with each high voltage pulse.

In principle, the device is reminiscent of the traditional Kettering ignition system fitted to motor vehicles. And just as ignition systems, in the days before noise suppression, created a lot of interference or 'hash' in radio receivers, so did spark transmitters, as in Fig.3, radiate a train of noise pulses.

As a rule, the buzzer or trembler was adjusted to operate at a make/break rate of a few hundred per second so that the signal, as heard, sounded like a continuous buzz rather than a series of plops.

In modern terms, it was a broad spectrum noise signal, much like that from any other piece of unsuppressed, spark-prone electrical equipment.

Aerial, earth, tuning

In the earliest transmitters or Hertz style 'oscillators', the spark gap was connected to bench-top metal rods terminated by rings or discs. Because of their modest dimensions and their relatively small mutual inductance and capacitance, they tended to be broadly resonant at some quite high frequency, thereby reinforcing the signal in that part of the spectrum; hence the earlier observation about the signals created by Hertz.

Subsequently, Marconi, Popov and others discovered that the effective range of the signals could be increased by connecting the rods respectively to earth and to a length of wire supported in space. In fact, the rods and discs could then be dispensed with. The same appeared to be true for receivers.

Although the reasons were only vaguely understood at the time, the aerial/earth arrangement was favouring the transmission and reception of signal components of greater wavelength or lower frequency, and with inherently different propagation characteristics. It was at this point that Sir Oliver Lodge intervened by rationalising inductance, capacitance and frequency and the need for deliberate 'syntonising' or *tuning*.

Up to about this time, Marconi had been concentrating on winning acceptance for wireless communication by relying mainly on brute force: i.e., by progressively increasing transmitter power.

In the process, another problem had emerged, namely that of mutual interference between separate wireless systems. An otherwise successful presentation by Marconi to the US Navy was discredited when he was unable to demonstrate independent communication between more than two stations at any one time.

1901 was a landmark year for Marconi in that he bridged the Atlantic with a wireless telegraph signal and patented a tuning system applicable to both transmitters and receivers – his famous patent No. 7777.

The patent attracted criticism that he had simply poached the ideas of Sir Oliver Lodge. In all fairness, however, while Lodge had spelt out the principles of syntony, it was Marconi who translated them into practice by resonating the coupling and antenna circuits of each transmitter to a particular frequency, and arranging for receivers to be individually tunable. Others adopted a broadly similar approach as a matter of necessity.

Admiralty Handbook

Surprisingly, my 1931 copy of the *Admiralty Handbook* contains helpful sections on spark and arc transmitters, along with the observation that such transmitters were still carried by some RN vessels as emergency communications equipment. At the time, a 'broad' distress signal was seen as a possible advantage, being more likely to be overheard by chance on nearby receivers.

Fig.4 shows their diagram for a contemporary low power spark transmitter, complete with aerial and earth and a

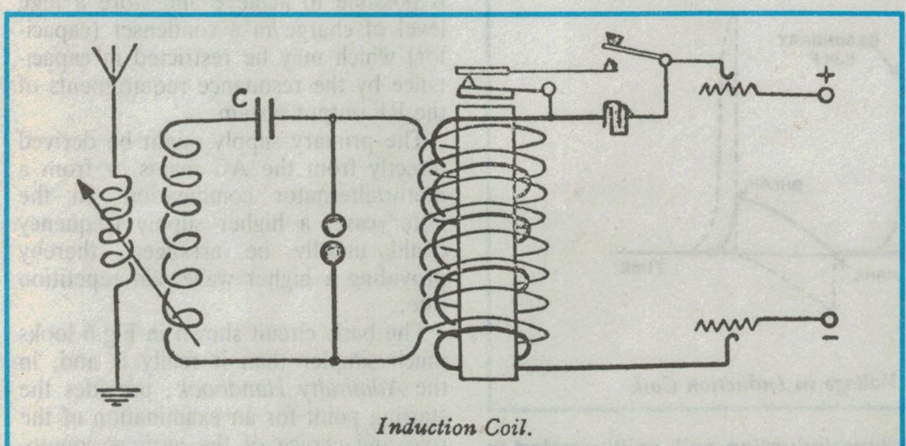


Fig.4: A buzzer type telegraphy transmitter. Pulses from the induction coil initiate bursts of oscillation in the aerial system.

tunable RF output coupling transformer. Fig.5 depicts the pulse generated across the secondary by the collapsing magnetic field.

According to the explanatory text, the moving vane or armature is typically a piece of soft iron attached to the end of a flat spring, with a screw adjustment for tension. Travel is normally about 1/16″ or 1.5mm. Platinum contacts on the rear face provide the necessary make-and-break circuit. A capacitor across the make/break and key contacts minimises spark corrosion and reinforces the inductive behaviour of the induction coil. Variable resistors in the supply line allow the DC input to be adjusted as/if necessary.

In operation, the high voltage pulse generated across the secondary charges capacitor C. As the pulse approaches its natural peak, the spark gap breaks down, causing C to discharge through the associated inductor, thereby creating a new, reverse magnetic field.

At this point, due to 'flywheel' action, the total output circuit generates a damped oscillatory wavetrain at its natural resonant frequency which, presumably, has been adjusted to the intended figure. The duration of the wavetrain following each pulse depends on the merit or Q-factor of the tuned system and is limited, amongst other things, by the amount of oscillatory energy absorbed by and radiated from the antenna.

In short, the effect of a properly designed resonant output coupling circuit is to concentrate the energy from a sequence of broad spectrum pulses into damped RF wavetrains of one nominal frequency. According to the *Admiraly Handbook* the repetition rate is typically in the range 250-1000 per second, which therefore becomes the basic 'pitch' or tone of the transmission – in effect, its modulation.

However, because the pulses are completely separate and of random phase as RF signals, the transmission as a whole has widely dispersed sidebands characteristic of grossly overmodulated AM plus random FM – being therefore still a very 'broad' signal, as mentioned earlier.

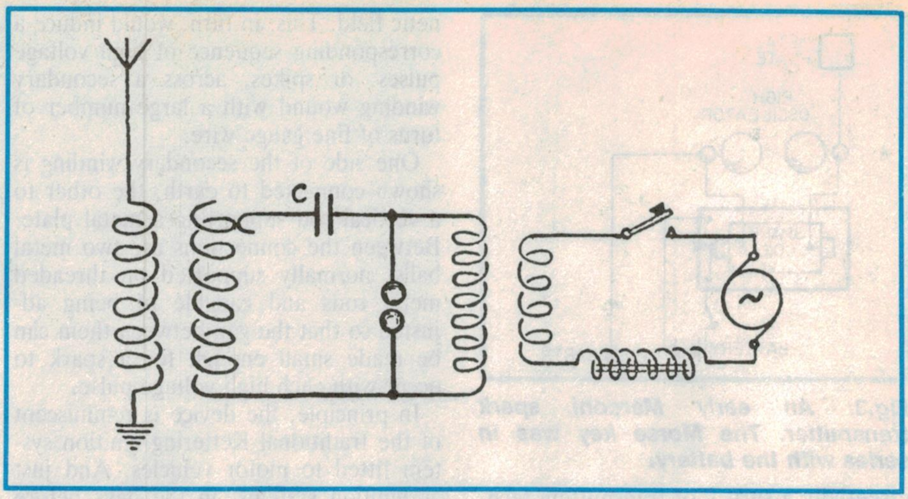


Fig.6: The basic circuit of an AC sourced spark transmitter. The design of such a circuit involved detailed design considerations...

Other approaches

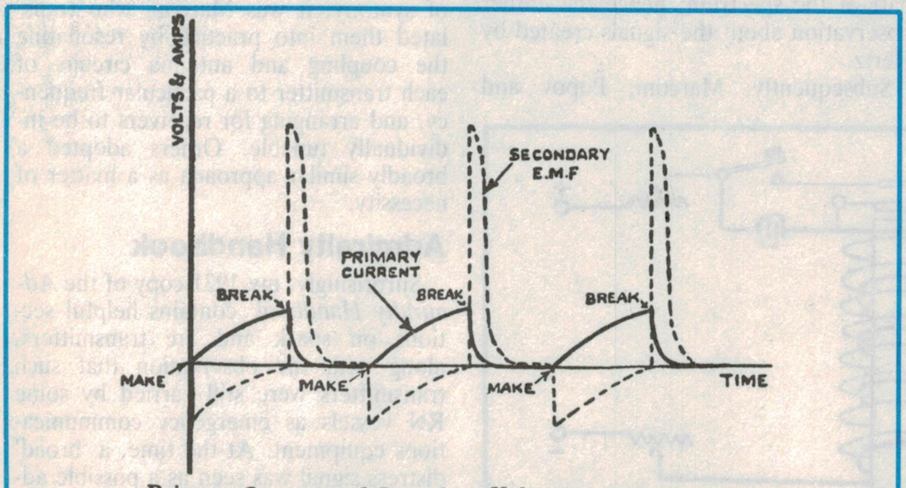
Literature of the period mentions variations from the above arrangement, the *Admiralty Handbook* referring in particular to the 'attracted armature' buzzer using a common primary winding to drive the armature and energise the resonant output circuit. It is said to have provided a cleaner, if lower-powered RF signal, suitable for setting up contemporary direction-finding equipment.

A still further approach was the so-called 'motor-driven' buzzer, in which the make and break function was provided by metal fingers riding on the surface of a spinning disc carrying alternate conducting and insulating segments. The induction coil is quite separate from the drive motor and an energising spike occurs each time a conductive strip breaks contact with a stationary metal finger.

For higher power transmitters, and certainly for anything above the half-kilowatt level, the most practical approach, according to the *Handbook*, was to use an AC supply source which could be stepped up to the requisite high voltage by means of a suitable transformer. With sufficient step-up, it is possible to achieve and store a high level of charge in a condenser (capacitor) which may be restricted in capacitance by the resonance requirements of the RF output system.

The primary supply might be derived directly from the AC mains or from a motor/alternator combination. In the latter case, a higher supply frequency could usually be arranged, thereby providing a higher wavetrain repetition rate.

The basic circuit shown in Fig.6 looks much simpler than it really is and, in the *Admiralty Handbook*, provides the starting point for an examination of the role and choice of the various components more detailed than can be repeated here. Look it up if you have the



Primary Current and Secondary Voltage in Induction Coil.

Fig.5: The current and voltage in a buzzer type induction coil, as illustrated in the Admiralty Handbook. The secondary voltage spikes initiate damped oscillatory wavetrains in the aerial output system.

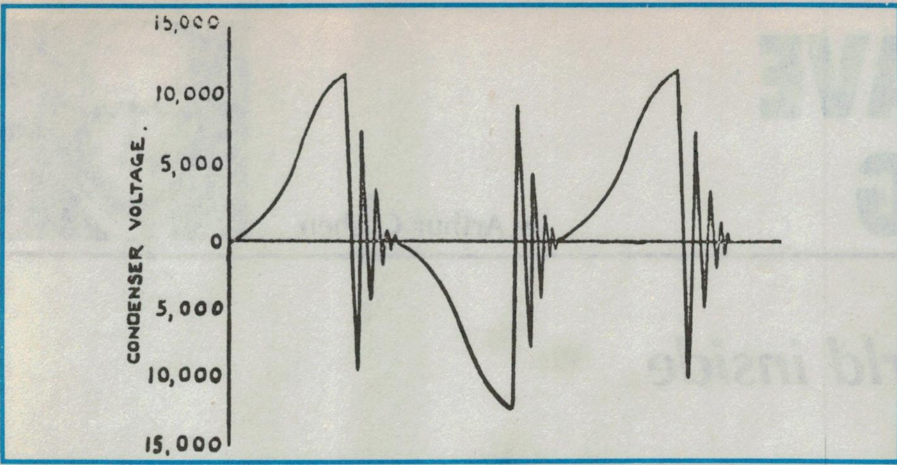


Fig.7: Illustrating the primary and secondary waveforms in an AC sourced transmitter with the gap set to break down, once per half-cycle, at something over 10 kilovolts.

opportunity, and you will gain a better appreciation of what Ambrose Fleming had to wrestle with in the construction of Marconi's Poldhu trans-Atlantic transmitter around the turn of the century.

Fig.7, from the *Admiralty Handbook*, illustrates the primary and secondary waveforms in a typical AC sourced transmitter, so adjusted that the spark gap breaks down just before the peak of each successive half-cycle.

Powered by a high frequency alternator, this would present an acceptable output signal but, operating directly from 50-60Hz AC mains, the pulse repetition rate would be less than optimum in terms both of average signal power and pitch, as heard.

To overcome the problem, at least in part, a non-synchronous rotating spark gap was commonly used, as in Fig.8. It involved a spinning disc with peripheral spark gaps, so adjusted that they would break down at a voltage well below the peak value of the AC input waveform.

By adjusting the speed of the disc, two or more discharges could take place within any one half-cycle of AC input (Fig.9) each spark being quickly quenched by the rapid relative movement of the gap components and of the surrounding air particles.

Inevitably, however, some wavetrains would fail to materialise when they coincided with the zero crossing region of the AC waveform. Use of an asynchronous gap, therefore, ensured a more audible, higher-pitched tone but also resulted in a broader, rougher signal by reason of the irregular timing of the wavetrains.

In short, while wireless telegraphy met the need for basic – and especially maritime – communication, the technology to this point in its development was relatively 'rough and ready' compared with the precision that was later to characterise electronic equipment.

It relied heavily on electro-mechanical disciplines, and on progress by trial-and-error, rather than on systematically applied research. Transmissions were unprecise and 'broad' in terms of the frequency domain, and were intercepted by receivers grossly deficient in reliability, gain and selectivity.

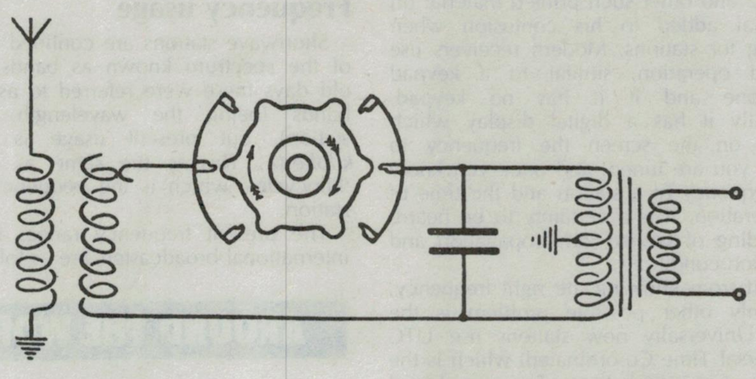


Fig.8: A rotating, asynchronous spark gap could raise the pitch of a mains-sourced telegraphy transmission – but with added 'roughness'.

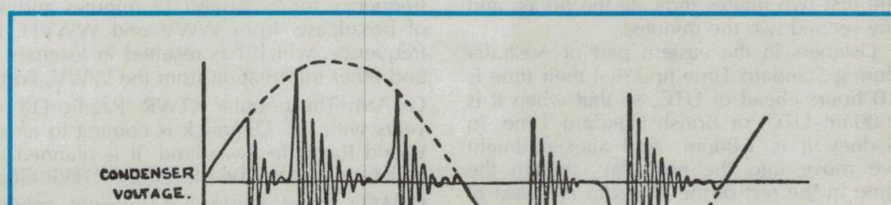


Fig.9: The effect of using a rotating spark gap in a mains sourced transmitter. There are two or more more wavetrains per half-cycle, giving a higher pitched tone but 'rough' because of less even spacing.

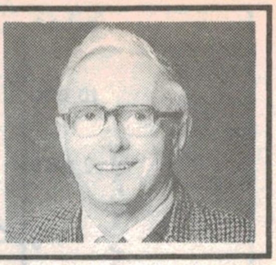
Despite this, professional operators developed amazing skill in using the medium, as was highlighted by an episode in the *Living History* series on ABC radio entitled 'Bright Sparks'.

Shipboard operators prior to and during World War I got to recognise other ships and stations from the sound of their transmitter. Individual operators were recognised by their 'fist' – their 'rhythm' in using the sending key. Maritime operators told how they could make an educated guess at the nationality of unfamiliar transmissions by German, Swedish, Norwegian, French, Italian and Egyptian operators, who unconsciously reflected their training in their operating style. Even the movement of distant ships could sometimes be deduced because their signals varied in a pattern that could be identified with known shipping routes.

In due course, the technology behind wireless telegraphy underwent a major revolution, partly because of the refinements which became necessary to accommodate wireless telephony, and partly because of the changes which spontaneously followed the adoption of thermionic valves. This will form the topic for next month's article.

SHORTWAVE LISTENING

by Arthur Cushen



Bringing the world inside

Here is the first of a series of segments designed to introduce the new shortwave radio listener to the joys of this pastime, and help them in becoming active.

The 'world outside' can be brought inside, right into your own home through shortwave listening. Gone are the days of jamming, deliberate interference and difficulties in reception, and shortwave listeners are now tuning to broadcasts using powers of half a million or a million watts, so that clarity of signals are assured. There are many voices clamouring to be heard on your shortwave radio.

The newcomer to shortwave will find that today's receiver no longer has the old analog dial, when the figures of 6, 7, 8, 9, 10MHz and other such printed material on the dial added to his confusion when looking for stations. Modern receivers use keypad operation, similar to a keypad telephone and if it has no keypad, generally it has a digital display which shows on the screen the frequency to which you are tuned, and once you know the frequency of a station and the time of its operation, it is a certainty to be heard, depending of course, on propagation and reception conditions.

Apart from knowing the right frequency, the only other possible problem is the time. Universally now stations use UTC (Universal Time Co-ordinated) which is the same as Greenwich Mean Time and based on the meridian through London. Therefore using a 24 hour clock system, the first two figures indicate the hours, and the second two the minutes.

Listeners in the eastern part of Australia during Standard Time find that their time is 10 hours ahead of UTC, so that when it is 3.00am UTC, or British Standard Time, in Sydney it is 1.00pm. And after midnight we move into the next day, though the time in the rest of the world to the west of us remains the previous day, so that at 1.00am in Sydney, it is 1500UTC, and it is not till we reach 10.00am in Sydney that the 'shortwave day' changes and in UTC the day becomes the same day as it is in Sydney.

Therefore if you tune in at 9.00am Sydney time it is 2300UTC the previous day, and when you are listening at 11.00am Sydney time it is 0100UTC, or 1.00am on the UTC clock.

Almost all international stations keep their schedules on UTC. Some countries which relay internal domestic radio services alter the broadcast times of transmission when they move to Daylight Time. That is, in the Northern Hemisphere from the last Sunday in March to the last Sunday in September, countries are on daylight time and Turkey, Israel, Finland and other countries are heard one hour earlier. As we move into daylight time in our summer, the Northern Hemisphere returns to standard time and these countries are heard one hour later.

Frequency usage

Shortwave stations are confined to areas of the spectrum known as bands. In the old days these were referred to as 'metre' bands (being the wavelength of the station), but present usage is to use *kilohertz*. This is the same as the old 'kilocycles' which is the frequency of the station.

The present frequency ranges used by international broadcasters are as follows:

Metre band	Kilohertz
11	25600-26100
13	21450-21750
16	17700-17900
19	15100-15450
23	13600-13800
25	11700-11975
31	9500- 9775
41	7100- 7300
49	5950- 6200

The World Administrative Radio Conference in 1979 decided to allocate additional frequencies, but this move has not yet been accepted – although in principle most broadcasters are moving out of these defined bands.

For instance the 31-metre band is now being used up to 10,000kHz, 25 metres from 11600-12100, 19 metres 15000-15700 and the 16 metres 17500-17900. But this is a very loose reference to the expansion undertaken by broadcasters – without, in most cases, authority from the World Administration Radio Conference.

AROUND THE WORLD

AUSTRALIA: The Australian Time and Frequency Station VNG which is operating on 5, 10 and 15MHz for 24 hours a day has advised that they will be standing by on the frequency for 9, 10 and 11 minutes and 46-51 minutes of each hour, to allow reception of broadcasts from WWV and WWVH. In the South Pacific VNG has dominated the frequency, which has resulted in listeners being unable to get the propagation prediction and other information from the WWV, Fort Collins, Colorado transmissions.

GUAM: The popular KTWR 'Pacific DX Magazine' which has been broadcast for many years with Bill Dimmick is coming to an end, as Bill and his family are moving to Trans World Radio in Swaziland. It is planned to produce a programme from TWR Swaziland which could later be played on KTWR Guam.

ISRAEL: Israel Radio has recently celebrated its 40th anniversary. The broadcast to Australia 0400-0415 in English is followed by a 15-minute programme in French and these are both carried on 17630kHz for this area. The additional channels are 9435, 11605 and 15640kHz. Further transmissions in English at 2130-2200 are on 12072, 15640, 17575 and 17630kHz. The address is: KOL Israel, External Services, POB 1082, Jerusalem 91010, Israel.

ITALY: The Italian Radio at Rome advises that they have temporarily suspended their Italian language broadcasts to Australia. This is due to considerable interference on their frequencies, in both the transmission at 2050-2130 and that at 0830-0930UTC. All other transmissions to other parts of the world are not affected by this temporary closure.

TURKEY: Ankara, Turkey is heard with English to the Pacific area 0300-0400 on 9445, 17760 and 17880, while the same frequencies are used for a broadcast at 2200-2300.

The reason why stations are moving outside the recognised bands is to avoid interference, and though attempts have been made to clear these areas for broadcasting they run into interference from teletype and other utility services which legitimately claim the right to use what is still at this stage, their authorised frequencies.

The increasing use of satellites is emptying the bands of these utility transmissions, and in due course this type of interference will disappear.

In future issues we will look at receivers, aerials, finding clearer frequencies through band surveys, the sunspots and their influence on shortwave reception. We will also look at the hobby as a retirement pastime, and how it can give tremendous interest to the disabled listener.

HCJB makes changes

Major changes have been made in the programme lineup of HCJB in Quito, Ecuador. All programmes produced in the Quito studios are broadcast in time blocks under the title of 'Studio 9' and for listeners in Australia this is 0730-0830 and 1000-1100UTC daily.

The first five minutes is Latin American news, followed by a 15-minute current affairs programme and for instance the programme for Radio Amateurs on Wednesday will be heard at 0750 and 1020. On Saturday, 'DC Party Line' for shortwave listeners is heard at the same time. Two frequencies are being used, 9745 and 11925 and the channel of 6130kHz has been dropped.

The 'Studio 9' programme will be carried three times to North America – at 0030, 0230 and 0500UTC and twice to Europe at 0730 and again at 1900UTC. 'DX Party Line' will be heard in all Saturday broadcasts, commencing about 20 minutes into the time block.

The service to Europe is well received in the South Pacific. The transmission 0730 is on 9610, 11835 and 15270kHz. The broadcast at 1900 is on 15270, 17790 and 21470kHz. 'DX Party Line' is hosted by Brent Allred and contains contributions from various radio clubs on the fourth Saturday of each month, such as the umbrella organisations, the European DX Council, Association of North American Radio Clubs and the South Pacific Association of Radio Clubs.

This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times quoted are in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time.

New communications receivers:

Icom's IC-R1 & R100 'mighty midgets'

Icom's new IC-R1 wideband communications receiver is almost unbelievably tiny – small enough to slip into your shirt pocket, and still leave space for a few pens! Its bigger brother the IC-R100 isn't much bigger, at about half the size of a typical car radio. Yet the R1 tunes continuously from 100kHz to 1300MHz, and the R100 from 100kHz to 1856MHz – with AM, FM and wideband FM reception modes in both cases. Jim Rowe has been trying them out, along with Icom's matching AH-7000 wideband discone antenna...

Back in the March issue this year, you may recall that I reviewed the new Icom IC-R9000 top of the line communications receiver. This is an incredibly powerful and flexible unit, with virtually every receiving mode and facility that you can imagine – and a performance to match. The R9000 is without a doubt the 'Rolls Royce' of communications receivers, and like other reviewers I gave it a 'rave' review.

Of course all of those facilities and that performance don't come cheap. The R9000 is by no means over-priced, considering what it offers, but all the same it doesn't leave much change from $8000; a little too high for most of us as private individuals (including yours truly, needless to say). It's also a bit of a monster, measuring 424 x 150 x 365mm and weighing in at no less than 20kg.

Happily those innovative people at Icom haven't rested on their laurels, though. Nor have they forgotten we more humble mortals with limited budgets. They've made use of the sophisticated technology developed for the R9000 and its slightly smaller brother the R7000, to develop the new R1 and R100. Both of these are much smaller and lower in price, yet still offer many of the basic features of their bigger brothers.

Naturally enough when the opportunity came to try out the two new 'mighty midgets', I jumped at the chance both to do this and to compare them with the R9000.

Duncan Baxter and his colleagues at Icom Australia also suggested that I might like to try out Icom's matching AH-7000 wideband discone antenna at the same time. This has also been very interesting, as discone antennas are one of the few types capable of working with receivers tuning over this kind of ultra-wide frequency range, and the AH-7000 is one of the very small range of such antennas currently available.

One thing at a time, though. First let's look at what must surely be the smallest wideband communications receiver ever produced...

The IC-R1

Nowadays I guess we've all become a bit *blase* about miniature electronics gear. Personal computers have passed through the desktop and laptop stages to the coat-pocket phase, and video camcorders have shrunk to the point where they appear likely to disappear up their own video output socket. Even radio gear has been steadily shrinking, with many single-band transceivers now down to the size where they can comfortably fit in the palm of your hand.

But despite all this, the new IC-R1 still seems a *very* impressive achievement. It's one thing to fit a single-band transceiver, or even a dual-band transceiver, into a handheld case; but surely another to do the same thing with the works of a complete continuous-coverage AM/FM/WFM communications receiver, tuning from 100kHz to 1300MHz.

And the R1 isn't just a handheld – it's a *tiny* handheld, measuring only 49 x 35 x 102.5mm and weighing a mere 280 grams (9.9 ounces, if you're an old timer). This is a receiver so small that it's bordering on being TOO small – with keypad buttons barely large enough and spaced apart enough to be operated reliably using adult male fingers. Any smaller, and we'd have to pass it over to the ladies or kids to operate for us!

Yet inside that miniscule case is not only all of the receiver circuitry to cover from LF to UHF, with triple conversion, full synthesiser tuning and programmable scanning, but also a built-in rechargeable NiCad battery pack.

Considering its tiny size, the R1 has a surprising number of controls – most of which perform multiple functions. The three rotary knobs on the top, from left to right, are for the squelch control, the volume control/power switch, and the tuning control (which is used in conjunction with the keypad, as explained shortly).

At the top of the 'front panel' is the LCD panel, which serves as the R1's frequency dial, S meter and indicator for the tuning step, receiving mode, scanning mode and memory in use. The latter is important because the R1 provides no less than 100 memories – each of which can store a frequency, receiving mode and tuning step 'recipe', capable of being recalled in a trice.

Alongside the LCD panel at the left are two small buttons; one to adjust the

display contrast, in conjunction with the tuning control, and the other a 'monitor' switch. This essentially defeats the squelch circuit, to allow continuous monitoring of weak and variable signals. Above the buttons and directly in front of the squelch knob is a small green flush-mounted LED, used to indicate when the R1 is receiving (or at least when it is 'unsquelched').

On the left-hand side of the case, just around from the contrast and monitor buttons, are a pair of larger buttons marked 'W' and 'F'. The larger of the two is the Function key, essentially a shift key for the keys on the keypad, while the smaller W button is used to activate the R1's digital watch and timer functions. (I forgot to mention that Icom's designers, not content with producing the basic R1 receiver, also threw in a 24-hour digital watch with programmable 'turn-on' and 'sleep timer' facilities...)

Further down the front panel, below the grille for the tiny built-in speaker is the main keypad. This has 16 keys, as you can see from the picture, and all perform dual functions according to whether or not you're holding down the F button.

As you might expect, 12 of the keys are used for keying in frequencies in 'unshifted' mode. These are the 0-9 numeral keys, the decimal point key and the 'EN' (enter) key. The four remaining keys and their equivalent 'base mode' functions are 'CL' (switches to direct frequency input mode, also stops scanning); 'MR' (switches to memory read mode); and UP and DOWN arrow keys, used to increment or decrement the memory channel number.

With the F key held down, all 16 keys provide a host of special functions including receive mode selection (AM/FM/WFM), tuning step size, writing to the current memory channel, setting the scan limits, starting the sleep timer, starting or stopping scanning and so on.

For tuning itself, the R1 provides two main options; but these are complementary rather than strict alternatives. For jumping immediately to a known frequency, you can simply key it in directly via the keypad. This is obviously the way to go when you're currently tuned well away from the target frequency, and you don't have the latter stored in a memory.

The second option is tuning up or down via the rotary knob, from the current frequency, in increments determined by the tuning step you've currently selected. This mode is more appropriate when you're already near the target frequency, or simply want to move around in a band.

The tuning steps available are 0.5, 5, 8, 9, 10, 12.5, 15, 20, 25, 30 or 50kHz – although not all of these may be available at any particular point on the R1's tuning range. For example the 9kHz step is really only available below about 1600kHz.

Actually the rotary control can be set to tune in larger steps again, by pressing the '9' key with the F button held down. This performs a 'dial select' function, allowing you to select which of the frequency select *digits* is adjusted via the control. You can thus select further tuning steps of 100kHz, 1MHz, 10MHz or 100MHz, for *really* rapid tuning.

Of course in addition to direct frequency selection, you can also save and recall complete frequency/mode/tuning step 'recipes' via the R1's 100-channel memory system. The contents of any memory channel can be recalled instantly using the Up and Down arrow keys, the rotary control (with the F button held down), or using the keypad (in memory mode) – making it very easy to switch between frequently-used frequencies, no matter how far apart they are in the spectrum.

Programming the memory channels is also quite simple. All you do is select an unused channel, and set up the desired frequency/mode/tuning step combination. Then you hold down the F button and press the MR key for two seconds, until the R1 emits three 'beeps' to signify that the data has been stored.

Of the 100 memory channels provided, all are available for general use. However channels 20-79 are also available to store unwanted 'skip' channels for scanning, while channels 80-99 can be used as 'bins' into which the R1 can automatically write data on active frequencies it finds during scanning.

In addition to these main memory channels, there are a further 10 pairs of memory channels dedicated to storage of start and stop frequencies for scanning. So if you store say 108MHz/AM/50kHz steps into scan memory 3A, and 135MHz/AM/50kHz into the matching memory 3B, the R1 can be made to scan over the aircraft band. If you want it to skip certain frequencies, these can be stored in the main memory channels between 20 and 79.

You can even change scanning ranges during scanning, by pressing a digit key on the keypad to select a new pair of scan limits – presuming that you've stored these previously, of course.

Quite apart from programmed frequency scan, the R1 can be arranged to scan the memory channels 0-19, in cyclic order. If you want it skip certain channels, this can be done too. You can

Here's the little IC-R1, only a tad smaller than life size. Can wideband communications receivers get any smaller?

even have it scan only the channels set for AM reception, or those for FM or wideband FM. And of course you can have it automatically store the details of any active frequencies found during scanning in memory channels 80-99, by selecting 'auto memory-write scan'. Pretty nifty!

Even that isn't all. There's also a 'priority watch' mode, where the R1 can monitor a memory channel or channels briefly (about 500ms) every five seconds, while you're listening to a particular frequency in normal VFO mode.

So basically the R1 provides all of the features of a scanner, in addition to its normal communications receiver functions – and with the advantage that scanning can be carried out anywhere in the spectrum from 100kHz to 1300MHz.

There are lots more functions too, but I think that gives you a good idea of the R1's basic capabilities.

The specs are quite impressive, too. The R1 uses triple conversion for AM and FM, with IF's of 266.7MHz, 10.7 MHz and 455kHz. For wideband FM mode it swings over to double conversion, using just the first and second IF's. Selectivity is rated at 'more than 15kHz/–6dB' for AM and FM, and 'more than 150kHz/–6dB' for WFM; whether these are effectively RF/IF bandwidths or true selectivity figures is a bit unclear.

The sensitivity figures are very impressive. In AM mode, the figure for 10dB S/N is 1.6uV between 2 and 24.9995MHz, and 0.79uV from 25-905 MHz. For FM and 12dB SINAD, the corresponding figures are 0.79uV and 0.4uV respectively, while those for WFM/12dB SINAD are 6.3uV and 3.16uV respectively. It's pretty hot.

Strictly speaking these figures are only guaranteed for the range from 2MHz to 905MHz, but the performance seems to degrade only slowly outside this range.

What this means is that the R1 picks up a huge range of signals, even with the little 'rubber ducky' helical whip antenna provided. We tried it out in a variety of locations – even inside our office building – and it picked up a huge range of signals, particularly on the VHF and UHF parts of the range.

With a more elaborate antenna the results can be even better, although the front end of the R1 is designed for sensitivity rather than large signal capability – so with a larger antenna you can get intermodulation and spurious reception of very strong signals. This is not surprising, and hardly a problem with a set designed primarily for hand-held use.

The R1 comes complete with operator's manual, a 'plug-pack' type charger for the inbuilt NiCad cells, rubber ducky antenna, handstrap, optional belt clip and mounting screws, and a plastic dustcap to cover the external DC input, external speaker and audio line output jacks.

And the price? Recommended retail is $725, but at least one dealer is currently offering it for as low as $649. Considering its capabilities and performance, this seems quite reasonable.

The IC-R100

Compared with the R1, the R100 is quite large – although at 150 x 181 x 50mm and with a mass of only 1.4kg (3.1 pounds) it's still very compact for a wide-range communications receiver.

Icom seems to be promoting the R100 primarily for mobile use, even supplying it with a hanger bracket; but in reality it's just as suitable for use in a fixed listening or 'base station' situation. The only complication is that it's designed to operate from a nominal 13.8V DC, so that a separate 240V power supply is needed. This can be quite small, however, as the average current drain is only a little over an amp.

The R100 is broadly comparable with the R1 in terms of functions and performance, although there are quite a few differences when you get down to the fine details.

Perhaps the most obvious difference is that the R100 tunes even higher into the UHF – from 100kHz right up to 1856MHz, in fact. As before the performance specs don't apply to the complete range, but here the different is quite small. The specs apply between 500kHz and 1800MHz, and judging by the performance between 100kHz and 500kHz the rolloff is fairly slow.

Another fairly important difference is that the R100 has an inbuilt RF attenuator, which can be switched in to prevent overload and cross-modulation with very large signals. The attenuator provides 20dB of loss, which is generally quite adequate to prevent problems – even when you're using an external antenna.

As well as the attenuator, the R100 also provides an RF preamp with 15dB gain, which can be switched in to boost weak signals. The preamp is only effective over the range 50 – 905MHz, but as this covers the main VHF and UHF channels in current use, this makes it very handy.

Needless to say, it wouldn't make much sense to have the attenuator and preamp in operation at the same time. In fact the R100's built-in microprocessor controls both, and only lets them be selected as alternatives to both each other and 'straight' RF input. It won't even allow the preamp to be selected, outside its operating range.

Like the R1, the R100 provides three basic reception modes: AM, FM and WFM. However the selectivity is a little more tightly controlled, being specified as 'more than 6kHz/–6dB' for AM, 'more than 15kHz/–6dB' for FM and 'more than 180kHz/–3dB' for WFM.

Sensitivity of the R100 on AM for 10dB S/N ratio (1kHz modulation at 30%) is specified as 3.2uV from 500kHz – 1.63MHz, 1.6uV from 1.63 – 50MHz, 0.56uV from 50 – 905MHz (preamp on), 1.0uV from 905 – 1380MHz and 1.4uV from 1380 – 1800MHz. The figures for FM (12dB SINAD, for 1kHz modulation and +/–3.5kHz deviation) are 0.56uV for 1.63 – 50MHz, 0.2uV from 50 – 905MHz (preamp on), 0.32uV from 905 – 1380MHz and 0.45uV from 1380 – 1800MHz. And for WFM, the figures for 12dB SINAD (1kHz modulation, +/–50kHz deviation) are 0.63uV from 50 – 905MHz, 0.79uV from 905 – 1380MHz and 1.1uV for 1380 – 1800MHz. In short, it's about 6dB better than the R1, in the AM and FM modes, and a very impressive performer indeed.

As with the R1, the R100 provides for tuning by either rotary control or keypad entry. However in this case there aren't quite as many tuning step choices: 1, 5, 8, 9, 10, 12.5, 20 and 25kHz. Also unlike the R1, there's no provision to let you select the active digit position, for larger tuning steps. But on the plus side, the R100 provides both an ANL (automatic noise limiter) function to reduce pulse noise during AM reception, and an AFC (automatic frequency control) function to cancel drift during FM reception.

Incidentally the specified frequency stability of the R100 is an impressive +/–3.5ppm at 1800MHz, so that this coupled with the AFC should allow very reliable operation.

As you can see from the photo, the R100 has a somewhat larger LCD screen than the R1, with correspondingly larger digits. It also has a similar trio of rotary controls for volume control/power, squelch and tuning. However the keypad has fewer keys – only 12, compared with 16, and there are only two extra control buttons. De-

And here's the IC-R100, at very close to life size as you can see from the pencil. Note that the LCD contrast is much better than is apparent in this shot. This set tunes from 100kHz right up to 1856MHz.

spite this the range of facilities is much the same, as quite a few of the keys have what are effectively triple functions.

Like the R1 the R100 provides 100 basic memory channels for storing frequency/mode/tuning step 'recipes', with the added feature that here the recipe also includes the RF preamp/attenuator enable status. As before memory channels 80-99 are also available for automatic storage of active channels found during scanning, and there are 10 additional pairs of memory channels to store scan range limits.

The basic memory modes are essentially the same as with the R1, as are the scanning modes. However where the R1 scanning resumes automatically after a pause of 10 seconds, upon finding a signal, the R100 provides a choice of three 'scan resume' conditions. These are OFF, where scanning pauses as long as the signal continues, and resumes approximately 2 seconds after it disappears; PAUSE, where scanning automatically resumes after 5 seconds even if the signal remains; and '∞', which cancels scanning altogether and stops on frequency when a signal is received.

The R100's clock and timer facilities are also a little more extensive than the R1, with the ability to have the set activate not just once but at a particular time each day, if desired. It can also be activated for an adjustable time, and tuned to a particular memory channel.

Other features specific to the R100 include a separate control at the rear to adjust display contrast, and an output jack (also at the rear) to control an antenna selector.

Incidentally the R100 has not just one antenna input, like the R1, but three; again they're all at the rear. A PL-259 'UHF' socket is provided for an antenna serving the range from 100kHz to 50MHz, while two further N-type sockets are provided for the ranges 50 – 905MHz and 905 – 1856MHz respectively.

The R100 comes complete with operating manual, VHF/UHF telescoping rod antenna, an HF wire antenna, a DC power input cable with both wires fused, a remote speaker plug, a 'hanger' mounting bracket, four rubber feet and mounting screws, spare fuses and a set of screws, nuts and washers.

In short, the R100 is a very impressive little package, offering very high performance coupled with a surprising number of features and facilities – considering its compact size. It seems very good value at the quoted retail price of $1061, including tax, although as before at least one dealer seems to be currently advertising it for as low as $899.

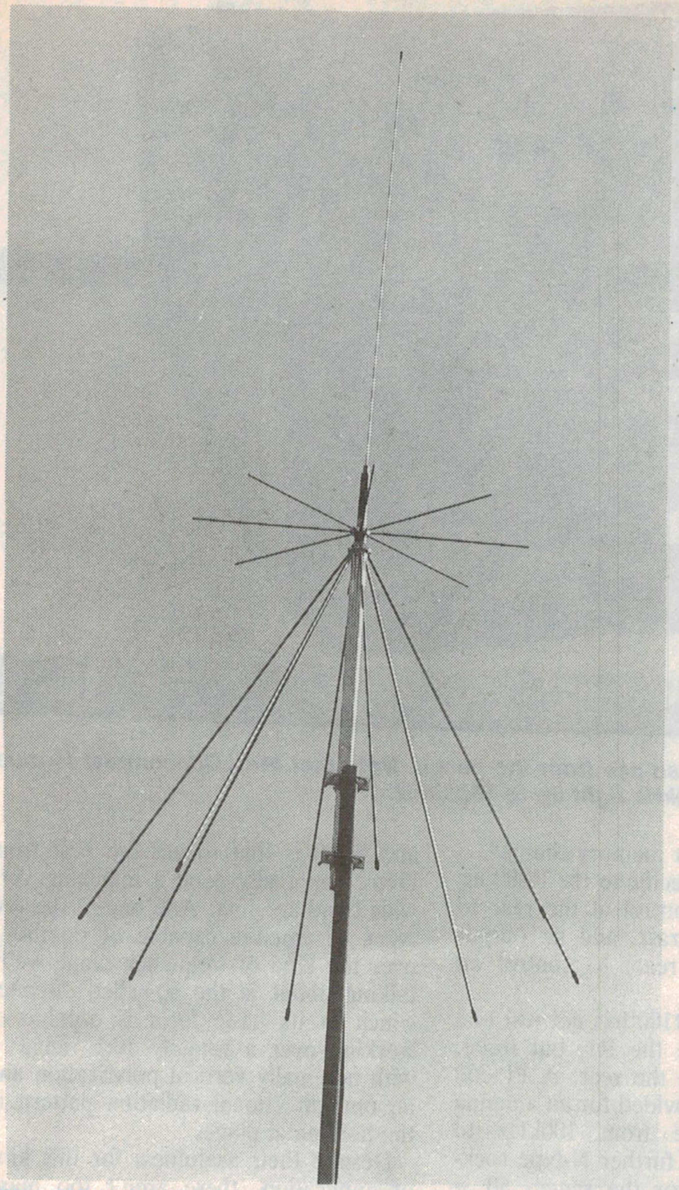
The AH-7000 discone

The only problem with using very wide tuning range receivers like the R1 and R100 is that to get the best from them, you really need a matching very wide band antenna. And one of the few types of antenna capable of operating over the kind of frequency range we're talking about is the so-called *discone*, which in its basic form is capable of working over a roughly 10:1 range – with nominally vertical polarization and an omnidirectional radiation pattern in the horizontal plane.

Despite their usefulness for this kind of application, there aren't too many discone antennas around at present. I was therefore very interested in the opportunity to try out Icom's AH-7000 discone, with the IC-R100 in particular.

The AH-7000 is actually a modified discone, with a loaded whip added to the top in order to extend its frequency range even further. In fact the rated operating range for reception is an impressive 25 – 1300MHz (50:1), and Icom also rates the AH-7000 for use as a transmitting antenna, capable of handling up to 200 watts on the 50, 144, 430, 900 and 1200MHz amateur bands.

Despite its wide range the AH-7000 is actually quite compact. Fully assembled it measures only about 600mm in diameter and 1.7m long, and weighs a mere 1kg. I was very glad of this when I had to hold it up – with 2.5m mast – with one arm, while balancing at the top of a long ladder, to fit it into a pair of support clamps!



The AH-7000 discone antenna is well suited for use with the R100, covering the range from 25MHz to 1300MHz. It's quite compact and light – but sturdy.

Both the 'disc' and 'cone' elements are in skeleton form, and made up in each case from eight rods about 4mm in diameter. The top whip is made from the same material. The disc rods are threaded at the inner end, and screw into the top of the hub with M4 lock nuts, whereas the cone rods slip into blinds holes and are clamped with small Allen grubscrews.

The hub is provided with an N-type connector on its underside, and this and the mating cable connector are normally protected from the elements by the mounting pipe. This is about 25mm in diameter by 500mm long, and attaches to the hub via three small set screws and lockwashers. Two mounting brackets with matching U-bolts and nuts are provided to attach the AH-7000's own mounting pipe to the normal mast, which can be anything from 25mm to 52mm in diameter.

Hopefully you can get a reasonably good idea of the construction from the photograph. It's all very nicely made, and the exposed metal is all either of stainless steel or plated to withstand the elements. There's even little plastic boots to fit on the ends of the top whip and the cone rods.

The AH-7000 comes with a 10m length of solid 5D-2V coaxial cable, already provided with N-type connectors to suit both the antenna itself and the R100. The whole package comes as a knocked-down kit, but goes together very easily using a Phillips-head screwdriver and a small shifting spanner (Icom supplies the small Allen key needed for the grubscrews). I had it up on the mast within about an hour of opening the box...

Quoted retail price of the AH-7000 is $232, by the way, which seems very reasonable.

And how did the combination of the R100 and AH-7000 perform? In a nutshell, very nicely indeed. With the AH-7000 mounted fairly high up at my home, I could pick up a vast range of signals; even at UHF they came in from all over the Sydney metro area, and as far afield as Wollongong, Penrith and Gosford. All sorts of signals, most of which we're not allowed to mention...

In quite a few cases the signals were so strong that to prevent cross modulation, I had to switch in the R100's 20dB RF attenuator – a bit drastic. One of the penalties of having a wideband front end, I guess.

On Sunday mornings I was able to tune in virtually all of the broadcast signals from the WIA's NSW Division transmitters at Dural, on all bands up to 1296MHz at good strength. This is over a distance of at least 30km, and with a ridge or two in between.

Of course the AH-7000 isn't too efficient down at HF, but in any case the R100 switches over to a different antenna input below 50MHz. I used a fairly high inverted-L antenna for the lower frequencies, about 10m long; it provided quite reliable reception down to at least 2MHz, and still tons of signal on the broadcast band.

One minor hassle I found with the R100/AH-7000 combination is that because the R100 switches between its two N-type antenna inputs at 905MHz, you have to swap the antenna cable over from one to the other when you swing from say 432MHz to 1296MHz – a bit of a nuisance with N-type connectors.

Presumably you could make a small box with a coax relay, driven from the R100's control output, to switch over automatically; but this would be a little expensive. I suspect that if they wanted to, Icom could probably make this unnecessary by allowing you to defeat the internal switching, so that the cable from the AH-7000 could be connected permanently to one connector. Perhaps this would be a nice feature for the next model.

Overall, though, the R100 seems to be a terrific little performer, and the AH-7000 combines with it to produce a very sensitive, flexible and easy to use ultra-wideband receiving/scanning setup. They mightn't be in quite the same league as an R9000 with no-holds-barred antenna farm, but they certainly provide most of the facilities needed by today's LF-to-UHF radio listener – at a much more affordable price!

So if you want a wideband communications receiver that will slip in your shirt pocket, the tiny R1 is for you. It'll pick up a surprising range of signals, with just the 'rubber ducky' antenna supplied.

But if you want a more powerful receiving setup, for either the car or a home/office listening post, the R100 plus AH-7000 combination would surely take quite a lot of beating. The only real drawback is the tendency towards cross-modulation, with strong signals; you can get around this with the RF attenuator, although a tuneable preselector would be better.

Further information on the IC-R1, the IC-R100 and the AH-7000 is available from Icom (Australia), 7 Duke Street, Windsor 3181 or phone (03) 529 7582. My thanks to Duncan Baxter and his colleagues at Icom for the opportunity to try them out.

WIN a superb Icom IC-R100 for yourself!

As *EA's* editor Jim Rowe found out for himself, Icom's new IC-R100 communications receiver is indeed a 'mighty midget' – offering continuous synthesiser tuning from 100kHz to an incredible 1856MHz, AM/FM/WFM reception, 100 memories, multimode scanning and a host of other features – all packed into a tiny case measuring only 150 x 181 x 50mm. It's also very impressive value for money, at an RRP of $1061.

If you're keen to lay your own hands on one of these mouth-watering little beauties, here's your chance to get one for NOTHING – or at least, very little. Those nice people at Icom Australia have generously donated one shiny new R100, to be won by a lucky reader of *Electronics Australia with ETI*.

All you have to do, to enter our 'Win an Icom IC-R100 Competition' is send in an amusing little story (preferably true!) – in 250 words or less – about ANTENNAS. Transmitting antennas, receiving antennas, weird antennas, masts and guy wires, feeder cables or whatever – we don't mind, as long as it's got something to do with radio antennas. How you slid off the roof and into the fishpond when you were putting up an antenna; how your antenna fell down during a storm and you only realised it because reception suddenly improved; how you used the rotary clothesline as an emergency antenna on 52MHz and it worked better than your big beam, and so on. Get the idea?

Just keep it short and light-hearted. The story judged to be best written and most amusing will not only win its writer the Icom IC-R100 receiver, but will also be published in *EA* to give everyone a good laugh. In fact we might even publish some of the runners-up, if they're good, and pay their writers a suitable fee as a consolation prize.

Entries close on November 30, to give us time to choose a winner and get the IC-R100 to them as a nice Christmas present. So start those fingers flailing on your typewriter or word processor, or get cracking with the pen and paper!

Send your entries to 'Win an Icom IC-R100 Competition', Electronics Australia with ETI, PO Box 199, Alexandria 2015. The winner will be announced in our February 1991 issue.

Silicon Valley NEWSLETTER

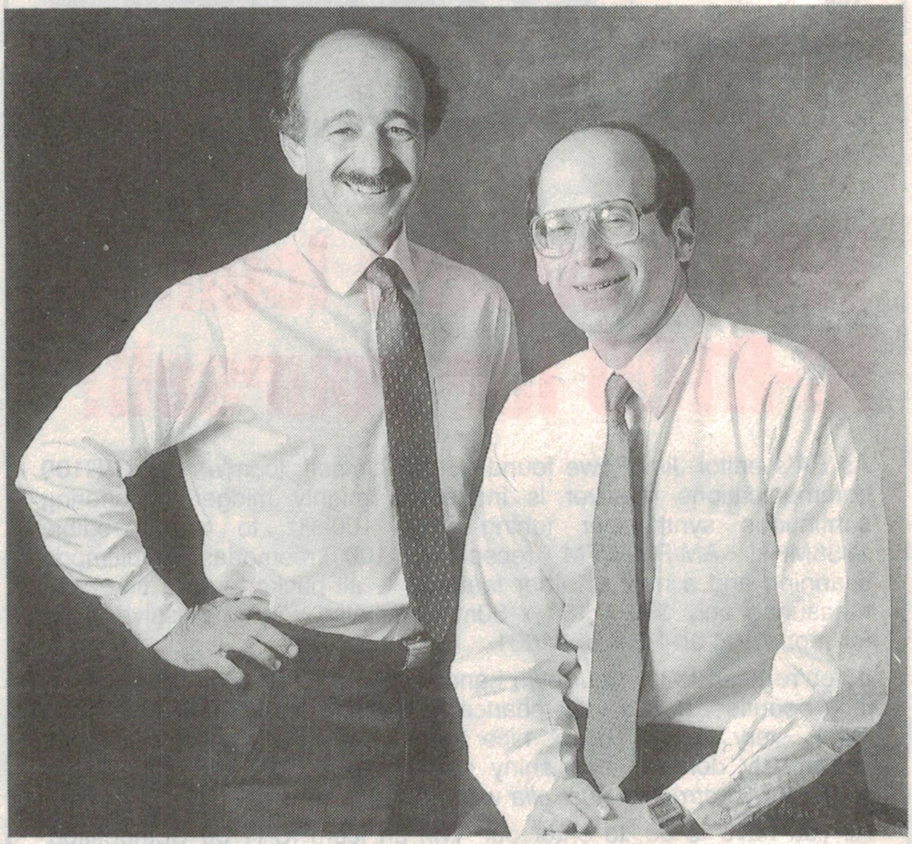
Congress relaxes anti-trust laws

The US Congress, concerned with America's declining role as a world industrial power, has passed landmark legislation that will vastly relax tough antitrust regulations that have been in effect for more than a century.

Under the rules of the new law, which President Bush was expected to sign, companies will be allowed to set up joint manufacturing ventures that will enable companies to vastly reduce the risk of entering new markets by sharing the cost of setting up expensive facilities to produce products.

The new law follows earlier legislation that is already allowing companies to jointly conduct research and development of new technologies and products.

A key provision in the new law is the removal of triple damages for antitrust violations in manufacturing. The treat of the huge damages that may result from an antitrust suit has kept many companies from exploring joint ventures even if they would not have broken antitrust laws. By removing this inhibiting factor, legislators of both parties said they expect more companies will to take risks in new and promising markets.



Tom Tomasett (L) and Jonathan Golovin are CEO and chairman/founder respectively of Mountain View firm Consilium, which specialises in integrated software for control and monitoring of manufacture. A growing number of Silicon Valley firms are making use of their software to lift productivity.

Motorola to drug test workforce

Following the example set by Texas Instruments, Motorola has announced plans to screen all of its 60,000 US workers for the use of drugs.

Under the terms of plan, all employees will have to submit to urine tests. If tests are positive, more complex and accurate tests will be required to confirm the initial results. Workers will then be required to enrol in a confidential drug counselling program. If they test positive a second time, they will be dismissed from their job.

Until now, Motorola has routinely tested job applicants for the use of drugs.

"Motorola has experienced problems with drug use, as have most major corporations. What we came up with was that a lot of our peple were concerned about a drug problem and felt that if we were going to do testing, the only fair way to do it was to test all of them," said spokeswoman Margaret Brown.

H-P and Hughes to make workstations

In an OEM deal that is expected to gross more than US$200 million during the next three years, Hewlett-Packard and Hughes Aircraft will jointly develop and market workstations for the military, government and aerospace markets.

Under the terms of the deal, Hughes' Ground Systems Group will buy H-P's workstations – the series 300 and 800 of the HP-9000 line. At Hughes, a team of some 100 workers dedicated to the venture, plus a number of H-P engineers, will customise the machines for different applications before selling them to its defence and other government customers.

The deal will allow Hughes to penetrate the rapidly-growing commercial workstations market with an established machine, further advanced with Hughes' technology. At the same time, the agreement will give H-P a chance to sell its machines into the US$1 billion-a-year military workstation market.

As part of the agreement, H-P will transfer its 'Tempest' anti-spy technology to Hughes. There, the two firms will jointly develop a high resolution tactical display workstation and ruggedise H-P's machines so they can survive in the military operating environment, particularly on the battlefield.

Minolta to sell Polaroid camera

In one of the year's more unusual US-Japanese trade deals, US camera maker Polaroid has announced that it will let Minolta sell its latest instant camera under the Minolta brand name worldwide, including the US. Polaroid said it hopes the use of Minolta's name will help increase its marketshare in the US and elsewhere.

To the casual observer it seems strange, to say the least, that a major vendor would put itself in a position of having to compete against its own product – since Minolta will not be making the cameras itself.

Unless Minolta is able to vastly expand the market for instant cameras, Polaroid may find itself sharing the same pie with its Japanese partner. Although Minolta, as the world's largest camera vendor, has a superb reputation with consumers, a brand name alone will not sell more product. Consumers must want the product. And the history of the instant camera shows that the market has remained pretty stable.

New Commodore Amiga computer

Commodore has announced a snazzy new computer that could wind up putting the company back into the spotlight.

The computer is the Amiga 3000, the latest machine from the company whose Commodore 64 once held a huge share of the home computer market in the early 1980's. When that market fizzled, Commodore's fame faded, and even the favourable reviews of the first Amiga in 1985 couldn't bring back the glory.

Since then, the Amiga has plugged along, gaining favour with a small but loyal sect of users drawn to the computers' built-in graphics, sound and video features that mark it as one of the first machines to offer so-called 'multimedia capability'. The company has even had some moderate success in Europe, but US buyers have largely ignored the machine in favour of IBM personal computer-style machines and Apple's Macintosh.

Now, with the top-of-the-line Amiga 3000 and a new management team that includes a pair of former Apple Computer executives, Commodore hopes to boost its flagging presence in the United States, moving its computers into businesses, government and education. And with almost every computer manufacturer flogging multimedia computing as the next great technology wave, Commodore thinks its machine is tailor-made to go along for the ride.

Using the same Motorola 68030 microprocessor as the NeXT computer and Apple Computer's top-end Macintosh systems, the Amiga 3000 boasts more power than any other computer Commodore has ever made. The basic Amiga 3000 uses a 68030 operating at a speed of 16MHz and includes a math co-processor chip, 2 megabytes of random access memory, a 40-megabyte hard disk drive and the built-in custom graphics and sound chips that have been the Amiga's hallmark. The company also offers a model with a 25MHz 68030 chip and will sell versions equipped with a 100-megabyte hard disk.

Like the Amiga models that have gone before it, Commodore will offer the Amiga 3000 at a considerably lower price than similarly equipped machines that use the 68030. The 16MHz version will have a list price of US$3299; the faster version will cost US$3999. By comparison, a Macintosh IIci with a 25MHz 68030 chip, coprocessor, 1-mega byte of RAM and a 40-megabyte hard disk costs UF$6969.

Apple changes profit program

Following an avalanche of bitter complaints, Apple Computer has announced it will modify a new profit sharing program that many felt was designed to cut their annual bonus payments. Apple chief John Sculley conceded that the new program he announced less than two months previously had generated 'bad feelings'.

"It is time that we focused our energies and got any bad feelings behind us," Sculley said.

Apple workers have enjoyed one of the most generous profit sharing programs in the industry, amounting to quarterly payments equal to between 10-and-15% of their annual salaries.

Under the existing plan profit was based on the company's gross profits. Under the new plan, which was scheduled to go into effect September 30, Apple planned to tie the size of the bonus to Apple's sales and profit growth rate. While in some cases that could mean even larger cheques for the 12,500 eligible workers, most felt that in the long run they would be getting substantially less as growth rates tend to vary wildly in the personal computer industry.

Employees felt that the requirement of a minimum 10% growth rate would have to be achieved to trigger profit sharing payments, was unfair in view of Apple's slowdown in sales and earnings growth.

Sculley said management had decided to lower the threshold to only 5%. "The overall message is that we want to all be in this together as one Apple," Sculley said in an E-mail message to all Apple workers.

AMD cuts jobs

In a new round of cost-cutting, Advanced Micro Devices has issued lay-off notices to some 200 workers in the product developments groups at the firm's Sunnyvale and Austin, Texas facilities.

Following the new cuts, AMD's workforce will have shrunk to around 12,000, down from as many as 18,000 in 1987. Another 500 workers will soon be off the AMD payroll as they are being transferred to Sony following Sony's recent acquisition of AMD's San Antonio facilities.

Company officials explained the new cuts in R&D are part of a program to make better use of the US$200 million AMD spends on research annually. The affected workers were involved in developing upgrades of products which have not sold well in the market place.

"We have spent a lot of money developing products that have not been accepted in the market place. We have to allocate money to the products that are accepted," said spokesman John Greenagel.

Japan now top chip equipment maker

Sales of semiconductor equipment declined during the first quarter of this year, and Japan overtook the United States as the world's leading supplier and market for vital chip-making equipment. Those were the major conclusions of a report released by the Semiconductor Materials and Equipment Institute, at the start of the group's annual Semicon-West trade show in San Mateo.

Despite the decline in first quarter sales, following more than two years of solid growth, the equipment industry appears destined to show overall growth during 1990. Trade figures Semi presented show orders exceeding shipments during March and April.

"This seems to indicate a good 1990, although it is still a bit early to tell," commented Semi president Bill Reed.

Motorola announces 'global' phones

Providing it can attract enough financial support, Motorola intends to build a satellite portable telephone network that will span the globe, allowing someone to make a call from the bottom of the Grand Canyon to a party atop Mount Everest.

A worldwide mobile telephone network has been the 'Holy Grail' of telephone engineering, and Motorola said it plans to become the first company to attempt to establish such a network with the help of no less than 77 small communications satellites and scores of earth-based relay stations.

The system will be based on Motorola's 25-ounce, $3500 portable telephone that is small enough to fit into an overcoat pocket. Customers would pay between $1 and $3 per minute when placing or receiving calls on the network. The company said it hopes to put the system on-line within the next six years.

In addition to business people in areas that are not currently served by cellular telephone, Motorola believes the network would appeal to vacationers, field engineers operating in remote locations, on planes and ships, and among disaster relief organisations that often work in areas where all forms of communications have been destroyed.

Motorola says that all of the necessary technologies to build the system are commercially available. In fact most of the technology is available in-house and the company plans to build the entire system itself. However, the cost of the network would still be enormous. Durell Hillis, who directs Motorola's satellite communications division said the price tag of the network will be in the US$2.3 billion range.

That is far more than Motorola can afford to spend and the company is seeking partners to share in the cost. It has already started talks with several potential partners including British Telecom as well as companies in Japan, Australia and Hong Kong. The bulk of the expense will involve the launching of the satellites. The company said it will take 77 small, 700-pound low-orbit satellites to ensure that one is always 'in sight' of any spot on earth. The launching of the satellites could begin as early as 1994.

To break even, Motorola said it will need at least 700,000 users, but based on market research and consultation with a number of major organisations that could be potential users, the company said as many as 5 million users worldwide may sign up for the service which will cost about US$100 per month.

Perhaps the biggest challenge to putting the network into operation will be of political nature, as a number of third world and anti-Western nations may not allow the system to operate over their territory. In third world countries, the Motorola system would pose a major competitive threat to the domestic telephone monopolies which often charge several dollars per minute for international calls even though the quaiity of their system is poor by modern standards.

Motorola said it will develop the network under the code name *Iridium*, the element that has 77 electrons orbiting its nucleus.

Toyota to use US chips

Japan's automobile maker Toyota has announced it has selected five major US chip companies to design and manufacture at least 33 special circuits, to perform key control functions in future Toyota model cars and trucks.

The five – Intel, Motorola, National Semiconductor, Texas Instruments and International Rectifier – will be making a host of parts, including power, engine, suspension and other control circuits.

Motorola spokesman James Edson said the recent trend among Japanese car makers to buy more US parts is encouraging. While Motorola has been the largest supplier to the three main US car makers, it has previously been able to win only a tiny portion of the vast Japanese auto components market.

Toyota is one of three major Japanese car makers that have announced intentions to increase US chip purchases. Earlier, Nissan and Honda said they would increase the foreign chip content of their cars. Toyota has set a target of buying US$28 million worth of US-made chips by 1992, about 10% of its total IC purchase budget.

First DAT recorders sell out

If there was any doubt that the United States presents a major market for digital audio tape recorders, the first week after the machines went on sale showed there is at least a massive pent-up demand following several years of legal wranglings that kept the machines out of the US.

Sony reported that virtually every one of the hundreds of outlets across the US sold out of their supply of US$950 DTC-75ES DATs, within the first couple of days. Many stores reported customers paying in advance for future deliveries.

DAT machines were finally allowed to be sold in the US after Japanese producers agreed to include a chip that makes it impossible to make copies of tapes containing recordings taken from CD players. For several years, the music recording industry lobby had successfully kept DAT out of the US, out of fear that many consumers and black marketeers would use a combination of DAT and CD players to make many 'perfect' copies of CD recordings.

Search for new Sematech chief

In the aftermath of the death of Robert Noyce, semiconductor industry officials are facing the challenge of finding a replacement to fill the position of chairman of Sematech. It is not going to be an easy task, industry observers say.

First of all, Noyce is leaving some very big shoes to fill, and few personalities in the industry match up to that level. Most of these are simply not available for switching to Sematech.

Also, few current industry executives would want Noyce's job of trying to take care of the interests and desires of the 14 companies that support Sematech – not to mention having to keep the US government about the deal which it is supporting to the tune of US$100 million a year.

Finally, Noyce was independently wealthy and was not looking to make a bundle from his job at Sematech – which does not offer stock options and huge salaries that some potential candidates may require.

For the latter two reasons, Sematech had a hard enough time two years ago finding someone to become its chief. Noyce only did so after a six-month search effort had turned up no-one and the lack of a leader put the viability of Sematech in serious doubt.

Once on the job, however, Noyce quickly took charge of the tremendous task Sematech faces. He steered the group in new directions, besides becoming a source of 'venture capital' for companies interested in developing highly advanced equipment. Sematech has taken on political roles, intervening directly in efforts to stop US semiconductor technology being sold off to Japan.

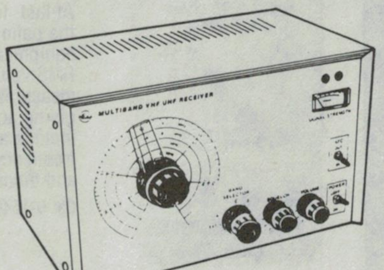
KITS

For The 6m Band!

Simple FM Receiver

You can now easily listen to amateur radio on the 50 to 54MHz band with this quality, yet very simple unit! In fact, most of the receiver functions on this unit, are performed by a single IC (the new MC3363 from Motorola)! This project will also form a basic 'turntable IF' receiver module for future converters, to cover other amateur bands! Full form kit with double-sided PCB, transformer, case and all necessary components.

Cat K-6005.



$139

144-148MHz Amateur Band Converter

This converter will allow you to receive the 2m amateur band on your 50-54MHz receiver (K-6005). The modular design of this circuit allows it to fit comfortably inside the K-6005 receiver, so changing bands will be as easy as flicking the switch.

Cat K-6006

$49.95

420-450MHz Amateur Band Converter

Another converter to give your receiver even greater versatility. By building this simple circuit into your K-6005 receiver along with the K-6006 2m converter, the 70cm band, which includes the popular 432MHz frequency will be yours to enjoy.

Cat K-6008

NEW!

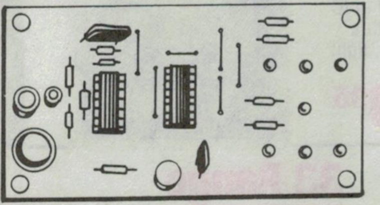
$39.95

Electronic Dice

This handy kit is more than just a random number generator. It displays its numbers in the traditional die format on two rows of three LEDs. You can even see the Electronic Dice counting as numbers roll by and stop just past that elusive six. Short form kit with all components, PCB, IC sockets, and battery holder.

Cat K-3532

$12.95

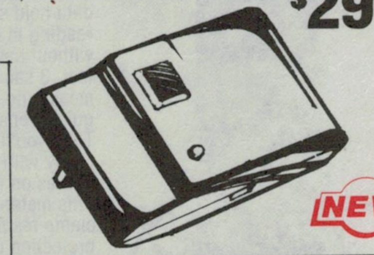


UHF Transmitter Key

This new design uses a SAW filter for improved frequency stability and eliminates the need for transmitter alignment. It features a flashing LED to indicate the button is being pressed and an automatic cut-out after 10 seconds if the button is accidently held down. Kit comes complete with all components, transmitter case and battery.

Cat K-3259

$29.95



NEW!

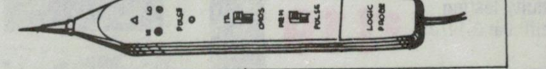
Logic Probe

This invaluable kit comes with a special purpose case, hardware and test leads. LED indicators on the probe will identify logic HI, LO or PULSE states in both TTL and CMOS logic circuits.

Cat K-7405

NEW!

$24.95

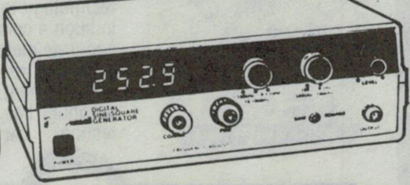


Digital Sine/Square Wave Generator

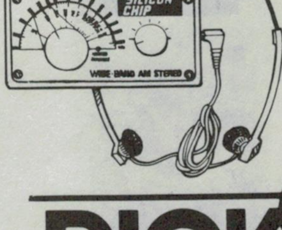
This new Digital Sine & Square Wave Generator uses high speed CMOS ICs and a digital filter to produce waveforms over a frequency range of 0.1Hz to 500kHz. It also features a 4- digit frequency readout, an output level control, and course/fine frequency adjustment.

Cat K-7350

$149



Portable AM Stereo Radio



Small, lightweight, superb stereo sound and incredibly easy to tune! The Wide Band AM Stereo Radio is quite simple to build and requires no fancy tools or equipment! Comes complete with case, stereo economy headphones, pre-punched front panel and all components. All YOU have to do is put it together, add two AA batteries and you're away!

Cat K-5200.

$79.95

Kits marked with this symbol involve mains power wiring. Take extreme care when working with this equipment.

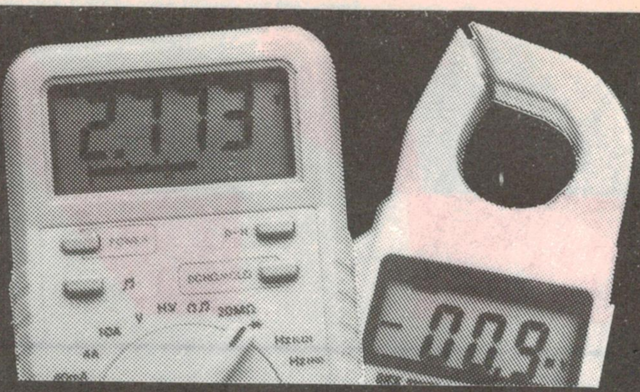
Degree Of Simplicity — Simple — Intermediate — Detailed

DICK SMITH ELECTRONICS

DIGITAL MULTIMETERS

Now You Can Afford To Go Digital

Our new range of digital multimeters come in bright safety yellow cases with large 13mm high LCD displays and pop out stands for easy reading.

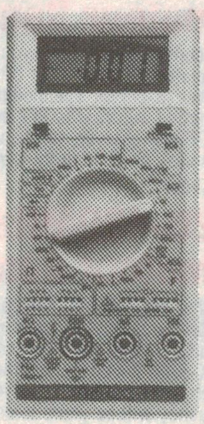


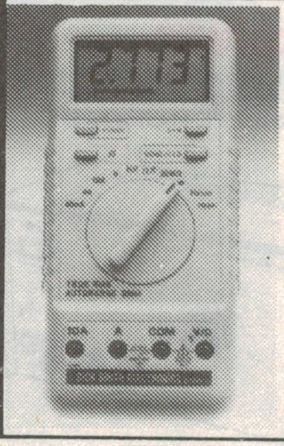
Mammoth 3999 Count Reading!

Full Range Digital Multimeter

This model represents great value for money with loads of features packed into its compact case. Features like auto-polarity, capacitor, diode, transistor and logic circuit test, frequency measurement (up to 4MHz!), and peak reading hold. Even comes with a smart vinyl carry case.

Cat Q-1450 **$99**



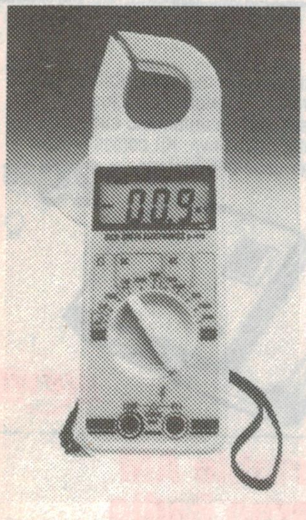


With Bargraph Display And True RMS!

3999 Count DMM

At last, true RMS measurements in the palm of your hand! Most test equipment does not directly measure RMS values. This one however, measures the value of the sine wave giving accurate readings. Features include auto ranging, data hold, frequency measurement, continuity, and diode test.

Cat Q-1540 **$199**



With Data Hold Switch

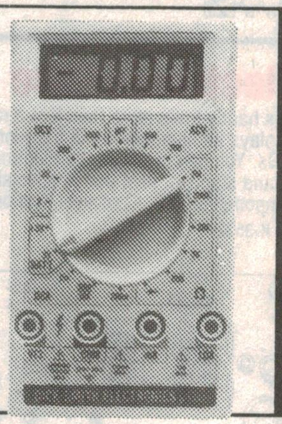
Digital Clamp Meter

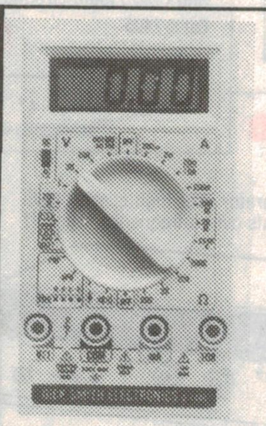
Measure heavy currents and voltages without breaking into the circuit with this 11 range multimeter. It has a data hold switch so you can take a reading in hard to get at places without having to see the display. Its fast, 3 samples per second, measuring rate will ensure you get quick, reliable readings every time. Then you'll be able to see them easily with the giant 15mm high figures on the custom LCD display. This meter does more than just take clamp readings. It has overload protection on all ranges and features diode testing, resistance, and continuity testing as well! Cat Q-1470 **$119**

18 Range Digital Multimeter

This pocket sized multimeter proves that performance can be a lot bigger than price! It takes three measurements per second to give you super-fast response over its 18 ranges and features the latest in IC technology to provide you with a highly reliable meter in a tiny, light weight package.

Cat Q-1442 **$49.95**





33 Range Digital Multimeter

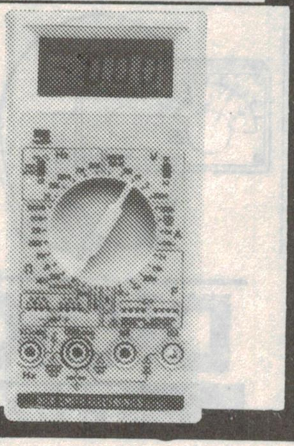
33 ranges in a pocket sized multimeter! This amazing little device can do almost everything you've wished a multimeter could do. It uses the very latest in IC technology to deliver these features in such a compact, reliable, and accurate meter. Some of those great extra features include frequency measurement, logic testing, continuity beeper, and transistor testing. Cat Q-1446 **$79.95**

Outstanding Value!

Full Function Digital Multimeter

Amazing value! You'll discover features you'd only expect in a meter costing much more! With a full range of functions, including diode test, capacitance and transistor test plus inbuilt frequency to 20MHz, and low power consumption allowing up to 200 hours of use.

Cat Q-1535 **$149**



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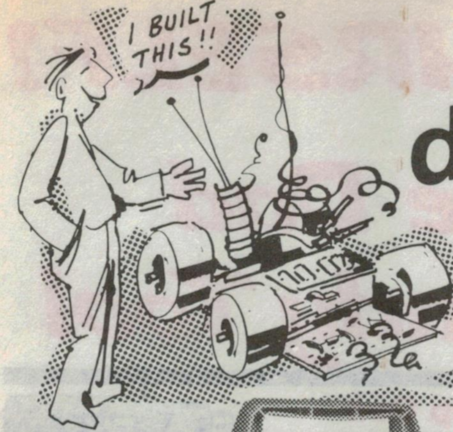

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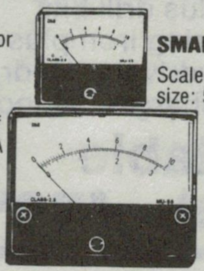
Design Your Own Circuits FAST AND EASY!

WISHMAKER II PROTOTYPE DESIGN STATION

With the Wishmaker II you can quickly and effortlessly build prototypes of your digital designs without the need for soldering, then test them with the vast array of test and measurement equipment built into this impressive unit. A rugged and portable design make the Wishmaker II a must for engineers, technicians, students, and hobbyists who need a device that can get their designs up and running fast! The Unit comes with a removable solderless breadboard, wire jumper kit with 350 assorted lengths, probes, and detailed manual. Cat Q-1435 **$499**

Item limited to larger stores

PANEL METERS *UNIVERSAL RANGE*



These 100uA universal panel meters can be easily adapted for any scale of Volts, Amps, or Ohms. By combining them with our SHUNT PACK and METER LABELS they will be capable of operating over the range 100uA to 10A and 1V to 100V.

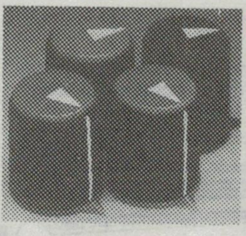
SMALL MU-45 TYPE-
Scale size: 55x30mm Overall size: 58x52mm Cat Q-2045 **$16.95**

LARGE MU-65 TYPE-
Scale size: 96x49mm Overall size: 100x82mm Cat Q-2065 **$21.95**

SHUNT PACK- Shunt resistors from 1.1 to 1,000,000 ohms plus resistance wire and instructions. Cat Q-2046 **$1.95**

UNIVERSAL TEST LEAD SET

Professional quality test leads for virtually any application in one screw-together system. Suitable for most meters and test gear. Comes with..... Coiled Leads fitted with insulated handles, 4 x 18mm (long) 1.5mm probes, Spade lugs, Alligator clips, Banana plugs, Right-angle adaptors. And they're all housed in a handy plastic wallet. **$25.95**
Cat Q-1935



COLOURED PLASTIC KNOBS

Now your projects can really look smart with these contemporary styled knobs. Use them to colour-code controls and even swap the inserts for greater variety.

Cat P-7050 **Red**
Cat P-7052 **Orange**
Cat P-7054 **Blue**
Cat P-7056 **Green**

ONLY **$1.95** *EACH*

RESISTOR SUBSTITUTION WHEEL

Select values from 5 ohms to 1M ohm in 36 steps using the most common divisions. Comes complete with leads and crocodile clips. Cat Q-1410 **$19.95**

PROTECTIVE POUCHES

LARGE ZIPPERED Suits many of the larger meters in our range. Cat Q-1514 **$9.95**

SMALL SOFT POUCH With Velcro zip. Suits our smaller meters. Cat Q-1513 **$9.95**

HOLSTER WITH BELT Lightly flexible yet hardy cradle which suits our Q-1516 DMM. Impact absorbing and can be worn on belt or used on the bench, etc. Cat Q-1522 **$4.95** *WAS $9.95*

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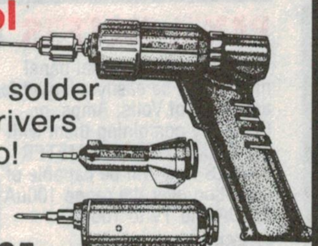
SPOIL YOURSELF! Or Give Dad a Handy Tool

The One Tool That Does It All!

3-IN-1 Modular Tool

- It's a drill plus drill bits
- It's a Soldering Iron plus solder
- It's a Screwdriver plus drivers
- And it's rechargeable too!



Unbeatable value at $79.95

Cat T-5712

Varitemp Iron

The one soldering iron that suits a range of applications. 240 volt operation with 25 watt capacity, makes it the ideal choice for an all-round iron. The temperature control is conveniently placed on the handle, and a great range of tips is available to suit most applications.

Cat T-1350

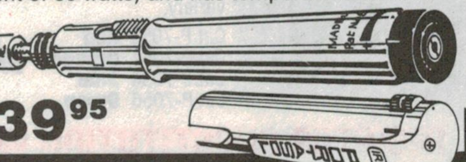
$29.95

Fits In The Pocket!

Butane Soldering Iron

The totally portable, butane powered soldering iron that will fit easily into your shirt pocket. It provides up to 60 minutes continuous use at full power (equivalent of 60 watts) and has temperature control from 10 to 60 watts.

Cat T-1370



$39.95

Heat 'N Strip Gun

A great tool to have around the house. Ideal for heatshrink work, removing old paint, drying... you'll find hundreds of uses for the Arlec Heat 'N Strip gun. It's mains operated and light and easy to use.

Cat T-4845

$62.95

Perfect For PCB Work!

ARLEC

Arlec Supertool

The Arlec Supertool takes the hassle out of working on PCB's. It sands, it polishes, it drills, it engraves, it mills. Comes complete with wire brush, milling cutters, grinding wheel, high speed drills, chuck collets, eraser sticks and plug pack adaptor-all in a handy carry case.

Cat T-4754

Just $79.95

Easy Etch Engraver

With the Arlec Easy Etch Engraver you can easily and quickly mark your tools, stereo equipment and household goods with a permanent identification. Steel bits let you engrave on metal, plastic, or wood. It's easy to handle and comes complete with a 12V plug pack and long cord.

Cat T-4753

$39.95

RED HOT SPECIALS!

Selected Portasol Replacement Tips

Normally $15.95 This month just $9.95

T 1368 Hot Knife suits	T 1370
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T 1377 Blow Torch suits	T 1374
T 1382 Hot Blow suits	T 1374
T 1379 3.2mm suits	T 1374
T 1381 4.8mm suits	T 1374

Gas Powered!

portasol PROFESSIONAL

The Professional 'Pocket' Soldering System

Ideal for the hobbyist, handyman or technician this butane powered kit allows you to make repairs anywhere, anytime. A must for urgent field work, etc! It's a complete soldering system with the equivalent of 10-60 watts of power and temperature adjustment up to 400 degrees Celsius. Your Portasol kit will include 4 tips, a cleaning sponge, and heavy duty case with clip-on iron stand.

Cat T-1374

$74.95

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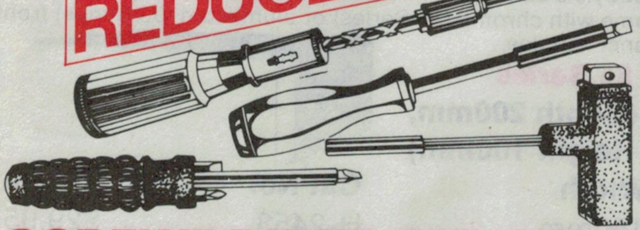
TOOL UP WITH THESE SAVINGS!

all stock REDUCED!



SCREWDRIVER BIT SETS

PUSH-ACTION	Cat T-4512	$6.95	SAVE $3
MAGNETIC	Cat T-4505	$6.95	SAVE $3
5 BIT SET	Cat T-4500	$4.95	SAVE $1
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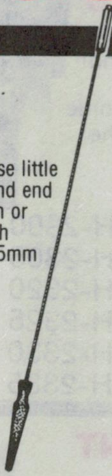
With Flexible Shaft!

MAGNETIC PICK-UP TOOL



Now it's easy to retrieve those little bits that go clank in night and end up at the bottom, underneath or caught up in your work. With insulated handle and 5 x 285mm flexible shaft.

Cat T-4530

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Just like a spare set of hands for the workbench or toolbox. Three sizes: 20 x 120mm, 20 x 80mm & 20 x 40mm. All three clamps fit to the 38mm magnetic base included in pack.

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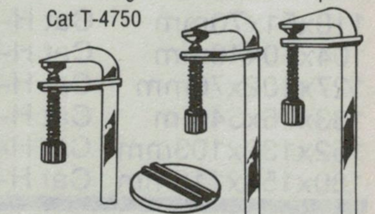

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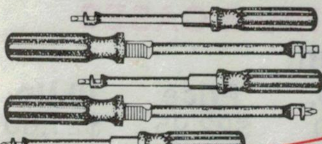
A high quality 5-piece screwdriver set that's fully insulated to help eliminate the 'Zap!' if you happen to touch the wrong thing. What's more, it 'holds' the screws so you don't drop them into awkward places. Comes with - 3 flat blades: 5 x 150, 4 x 125 & 3 x 125mm. 2 x Phillips head: No's 1 & 2. Cat T-4395



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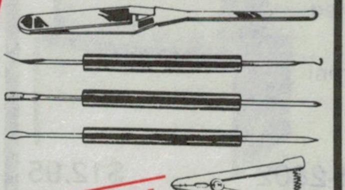

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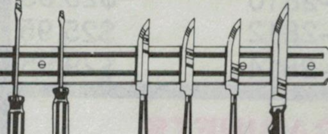

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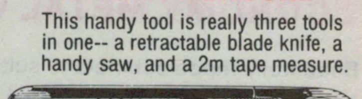

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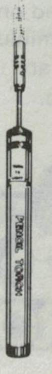

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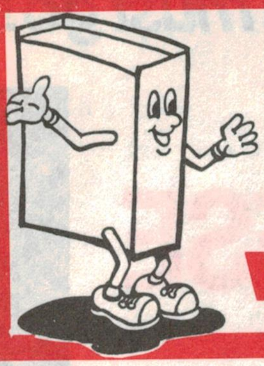
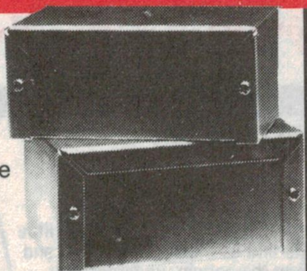


What ever the size of your project, we have a case to fit!

ALUMINIUM BOXES



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110x51x70mm	Cat H-2300	$6.95
104x60x46mm	Cat H-2305	$5.95
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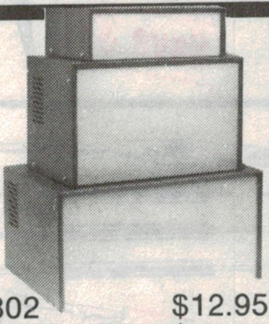
133x76x54mm	Cat H-2325	$6.95
152x132x103mm	Cat H-2330	$9.95
180x158x118mm	Cat H-2335	$12.95

K & W INSTRUMENT CASES



These cases are solidly constructed with a hammer tone steel cover, aluminium base, and recessed front panel.

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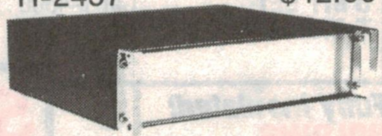
Superbly finished, beautifully constructed and designed Horwood instrument cases are a favourite amongst hobbyists and project builders alike. They look good and come with chrome (84 Series) or aluminium (93 Series) front panel handles.

84 Series (Depth 200mm, Height 100mm)

Width	Cat No.	Price
150mm	H-2453	$29.95
200mm	H-2454	$31.95
250mm	H-2455	$34.95
305mm	H-2456	$39.95
425mm	H-2457	$42.00

93 Series (Depth 230mm, Height 75mm)



Width	Cat No.	Price
150mm	H-2462	$25.95
200mm	H-2463	$27.95
250mm	H-2464	$29.95
305mm	H-2465	$32.95
425mm	H-2466	$34.95

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EXTRUDED ALUMINIUM CASES

76 x 102mm

Length	Cat No.	Price	10 Up.
76mm	H-2420	$22.95	$21.80
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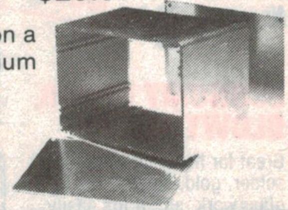
153mm	H-2430	$29.95	$28.45

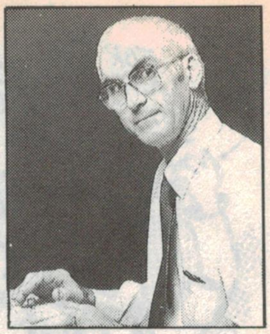
A superb range of cases based on a specially made 18 gauge aluminium extrusion giving cases which are ultra strong and ultra reliable.



DICK SMITH ELECTRONICS

FORUM

Conducted by Jim Rowe



Fancy audio cables: more letters, and the results of our listening tests

There's obviously still a lot of interest in the subject of fancy audio cables, judging from the letters and phone calls I've been receiving. So here's some further cogitations and ruminations, followed up by a report of what we found when we listened to various kinds of cable hooked into a high-level system...

As it happens the longer of the two letters I'm going to print on the subject this month had arrived *before* I prepared last month's column, but I put it aside to give Mr Cardas the opportunity to reply to my comments on his cables, published in the May column. So it's only fair that I publish it this month, and as first cab off the rank.

It's actually from our old friend Phil Denniss, from the Department of Plasma Physics at Sydney University. (Sorry to have delayed your letter, Phil, but I hope you'll understand!) And here's what he has to say about the subject, which I think you'll find quite interesting:

I must confess that like you I am quite skeptical about the need for any of the exotic cables that one can find advertised in many magazines and sold at hi-fi and electronics stores, and my reasons are basically as follows.

First, there is very little scientific evidence presented to support the claims made. There have been some hard data presented to support the idea that speaker cables should be oxygen free, high conductivity, linear crystal or a combination of the three. However virtually none of it has been presented in a logically connected way, that might stand as scientific proof that there is any measurable improvement in using any of the exotic (and very expensive) cables, whether for speakers or for low level signals. An example of this is in the December 1988 Forum about cables, concerning some experiments conducted by a Mr Kamada.

Second, most of the evidence presented in support of these exotic cables is anecdotal and based strongly on the perceptions and biases of the reviewer. I would have thought just about everybody in audio knew that the human ear-brain setup is notoriously adept at deceiving even the most clever and experienced individuals, when it comes to making quantitative **and** *qualitative assessments of audio equipment. Psychoacoustics is essentially the study of these effects.*

Audiometry can become extraordinarily complicated, simply to eliminate the influence of the brain on what we hear. Reviewers often seem to ignore the fact that what they hear is coloured by so many influences that they cannot control nor discount, that what they say is mostly their opinion of an event and pretty worthless as hard evidence. A-B testing I think is the only reliable testing done with the human ear, and this process has never been used in any reviews I have seen regarding cables.

Third, the comparatively gross distortions caused by the loudspeakers would swamp any effects in most speaker cables. Hi-fi loudspeakers tend to be the real weak link in the music reproduction chain, often producing remarkably high levels of distortion and having anything but a flat frequency response. If the speaker cable did introduce audible degradation of the music, then we should be able to measure some imperfection in the behaviour of the cable. After all we can measure the imperfections in a loudspeaker system, and to much greater accuracy than we could identify with only our ears.

Which brings me to the question - is a piece of wire measurably nonlinear? There is precious little evidence of it; I have seen only one passing reference to any study of the nonlinear behaviour of wire. And yet it is this point that is pivotal to the discussion, because it is implicit that simply decreasing the resistance of the cable, or by changing the capacitance or the inductance of the cable, does **not** *produce the required effect. Otherwise there would be no need for linear crystal oxygen free high conductivity copper cables, or some such alternative.*

I have participated in two simple experiments to measure the nonlinearity of some pieces of wire, and I might as well say at the outset that neither experiment showed any nonlinear behaviour that could in any way be attributed to the wire.

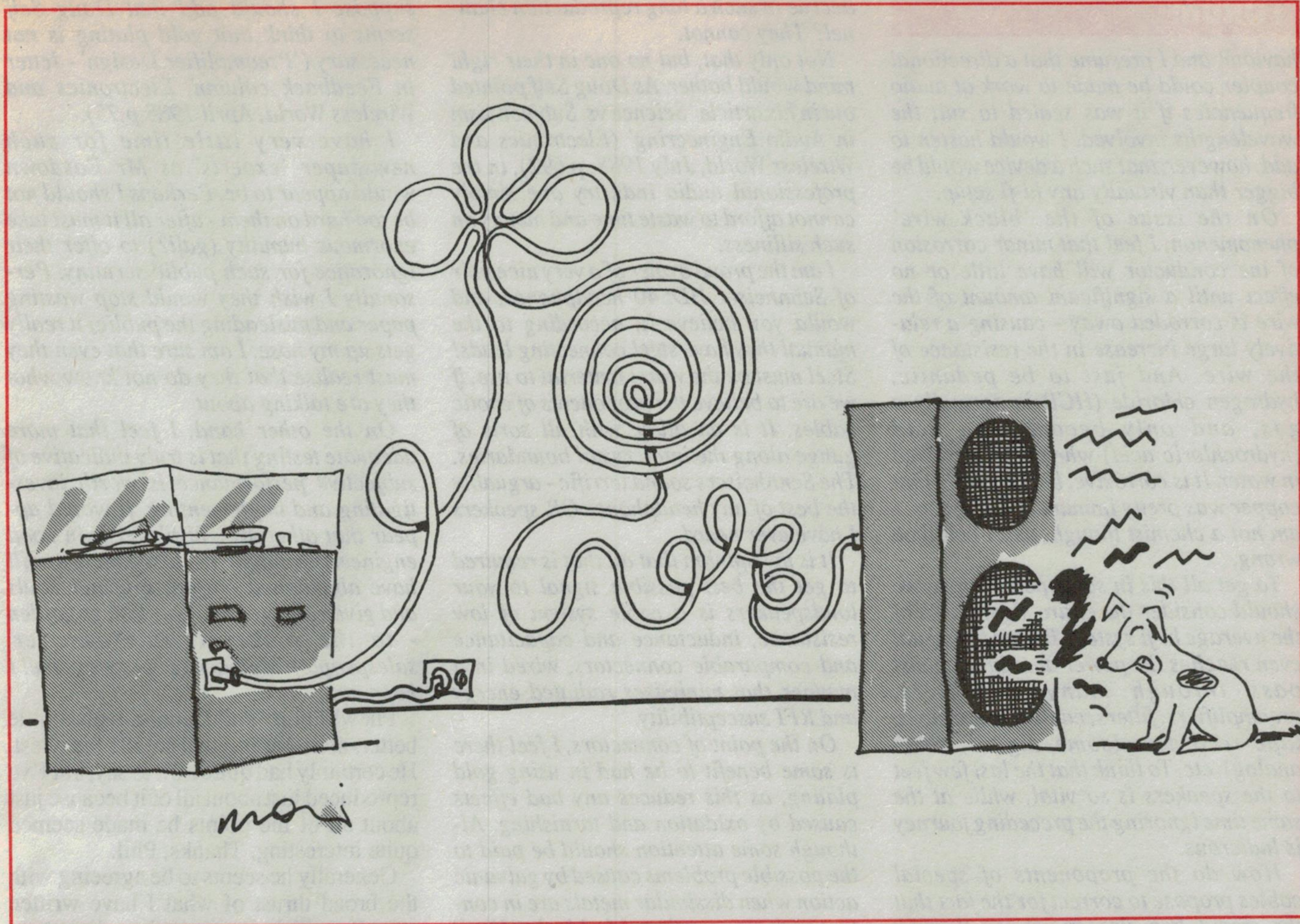
The first experiment I conducted by myself. It was quite straightforward; I simply connected a length of wire to a constant current supply and measured the voltage across the wire and the current in the wire, at various currents from a few milliamps (the smallest current that produced a measurable voltage drop) to three amps - the limit of the supply. The wire used was $1.0mm^2$ mains wire of 32 strands 0.1mm in diameter, probably capable of carrying 10 amps without much stress; pretty ordinary and fairly typical of the crude 'interconnects' that philistines like myself might use.

The resultant data when plotted lined up almost perfectly on a straight line going through the origin. The points that did not lie on the line were well within the 1% limit of accuracy of the setup.

The next experiment was devised by one of the research students at Plasma Physics, Mark Ballico, and I am indebted to him for his ingenuity and enthusiasm. What was proposed as a quick half-hour experiment took, in the end, most of the afternoon!

The idea is very similar to a standard intermodulation distortion test, performed on any normal audio amplifier. A circuit of the setup is enclosed, and as you can see it is pretty simple. A transformer with a centre-tapped secondary of six turns (total) was constructed using a 100VA transformer kit, with the primary already wound. We used fairly light gauge wire (ten strands each 0.1mm in diameter) because we figured it would require less current to show any nonlinearities.

The circuit was wired in such a way as to minimise the amount of 50Hz and associated harmonics from appearing in the signal we were measuring with the spectrum analyser. We chose the second



frequency (from the low distortion oscillator) to be about 5kHz - but not a harmonic of 50Hz, so that it would be clear which frequency components were from the mains, which components were being produced by the oscillator and which were produced by any nonlinear behaviour of the wire.

The spectrum analyser was used because of its ability to resolve low amplitude frequency components in the presence of other relatively larger ones. The 50Hz current in the wire was 1.5A; the wire is rated to carry 0.5A.

And the result? We could detect no intermodulation products, less than 65dB below the 5kHz signal. ***All*** *of the spectral lines that were visible were contributed by the mains, or by the low distortion oscillator.*

To put it another way, we saw absolutely no evidence of any intermodulation products, and if there were any they were significantly less than one thousandth of the voltage (one millionth of the power!) of the 5kHz signal. This implies that the wire caused much less than 0.1% distortion.

This does not represent a stunningly low level of distortion, but it is well below those levels generated by most hi-fi loudspeakers, and it is comparable to the distortion levels of those expensive valve amplifiers that audiophiles of the 'subjectivist' school love to use!

I will now address some of the specific points in your February Forum column. Mr Easdown says that the "... more delicate wire is reserved for the higher signals". One assumes that he means for the higher ***frequency*** *signals, but only by reading the context of the statement. This is so much manure (good for fertile imaginations!), because at ALL audio frequencies the fatter wire will have the lower impedance and will hence carry more current.*

The designer of the cable may ***try*** *to 'reserve' the 'more delicate wire' for the 'higher signals', but the current has other ideas! It is going to take all paths, and most of it will flow down the easier path - regardless of frequency, power or how 'high' the signal may be. It is simply stupid and wrong to suggest otherwise. To split the audio spectrum as is suggested would require a cross-over network, in the same way that we use cross-overs in loudspeaker systems with several drivers.*

On page 51 you consider what might happen to the average consumer if they bought some fancy cable and tried it out. The truth is that to perform ***any*** *meaningful audio test by ear you really must use the A-B technique, preferably double blind, and in this instance it should be done in the customer's listening environment with the customer's hi-fi equipment.*

This is not really practical unfortunately, and so the retailers of these fancy cables must feel pretty secure. They must know that the customer has no way of properly testing their (the retailers') claims. This is a rather dubious business practice.

On page 52, you talk about the supposedly directional properties of some exotic cables. The fact is that for any audio signal, one can safely say that the power flows from the source to the load. But the current flows backwards and forwards in the wire - it is after all alternating current that we are talking about. My limited understanding of Maxwell and Poynting and their work says that the ***power*** *delivered to a load from a source actually flows through the space around the cable, and only the current flows down the cable.*

By the way, directional couplers used at radio frequencies can couple power into a cable that will flow only one way in the cable without any nonlinear be-

haviour, and I presume that a directional coupler could be made to work at audio frequencies if it was scaled to suit the wavelengths involved. I would hasten to add, however, that such a device would be bigger than virtually any hi-fi setup.

On the issue of the 'black wire' phenomenon, I feel that minor corrosion of the conductor will have little or no effect until a significant amount of the wire is corroded away - causing a relatively large increase in the resistance of the wire. And just to be pedantic, hydrogen chloride (HCl) is normally a gas, and only becomes an acid (hydrochloric acid) when it is dissolved in water. It is corrosive, but I thought that copper was pretty immune to its effects. I am not a chemist though, and I could be wrong.

To get all this in some perspective, we should consider the entire signal path of the average hi-fi system. Before the signal even **reaches** *the power amplifier it must pass through many amplifiers, preamplifiers, filters, cables, connectors, tape recorders (some digital, some analog), etc. To think that the last few feet to the speakers is so vital, while at the same time ignoring the preceding journey is ludicrous.*

How do the proponents of special cables propose to correct for the fact that the signal has already passed through nickel, tin, brass, silver, steel, kovar (used in some transistors), silicon (imagine what silicon must do to the stereo image!) and even a partial vacuum (if they use valve amps) - and the inevitable loss of detail and clarity that would doubtless accrue in such a long reproduction channel? They cannot.

Not only that, but no one in their right mind would bother. As Doug Self pointed out in his article 'Science vs. Subjectivism in Audio Engineering' (Electronics and Wireless World, July 1988, p.692), in the professional audio industry one simply cannot afford to waste time and money on such silliness.

I am the proud owner of a very nice pair of Sennheiser HD540 headphones, and would you believe it, according to the manual they have **steel** *connecting leads! Steel must be the worst material to use, if we are to believe the proponents of exotic cables. It is an alloy, with all sorts of gunge along the intercrystal boundaries. The Sennheisers sound terrific - arguably the best of any headphones OR speakers I have ever heard.*

It is my opinion that all that is required to get the best possible signal to your loudspeakers is a cable system of low resistance, inductance and capacitance and comparable connectors, wired in a manner that minimises radiated energy and RFI susceptibility.

On the point of connectors, I feel there is some benefit to be had in using gold plating, as this reduces any bad effects caused by oxidation and tarnishing. Although some attention should be paid to the possible problems caused by galvanic action when dissimilar metals are in contact with one another. J.L. Linsley Hood ('Spot Frequency Distortion Meter', in Wireless World, July 1979) recommends the use of gold-plated connectors for ultra low distortion, but he is talking about distortion levels of less than one part in one million (.00001% of 10V)! I suppose I should add that Doug Self seems to think that gold plating is not necessary ('Preamplifier Design' - letter in Feedback column, Electronics and Wireless World, April 1985 p.75).

I have very little time for such newspaper 'experts' as Mr Easdown would appear to be. Perhaps I should not be too hard on them - after all it must take enormous humility (gall?) to offer their ignorance for such public scrutiny. Personally I wish they would stop wasting paper and misleading the public; it really gets up my nose. I am sure that even they must realise that they do not know what they are talking about.

On the other hand, I feel that more adequate testing that is truly indicative of subjective performance is worth investigating and implementing. It would appear that otherwise, hi-fi's basis in good engineering might be lost and we will have abandoned reason, sold our souls and given away our ears - cloth or golden - to the snake oil salesmen (er, salespeople). Mediocrity here we come! I hope not.

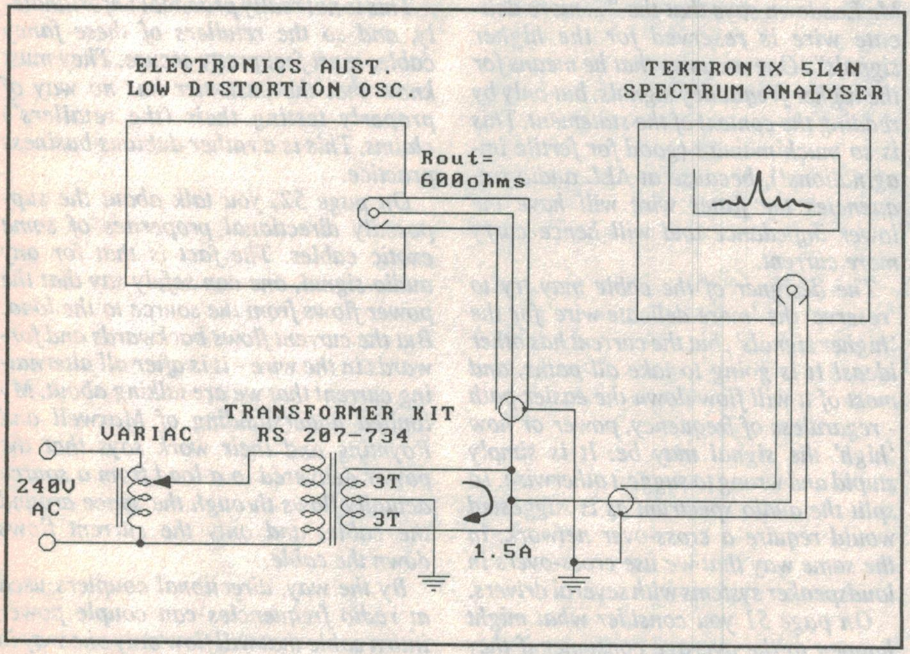
Phew! I hope Phil Denniss feels a little better, after getting that lot off his chest. He certainly had quite a bit to say, but I've reproduced just about all of it because just about all of the points he made seemed quite interesting. Thanks, Phil.

Generally he seems to be agreeing with the broad thrust of what I have written myself, which is reassuring. I've suggested myself that for any really meaningful auditory comparisons, you really need to perform A-B testing, and preferably using the double- blind technique - where neither the listeners nor the person doing the A-B switching knows which of the items being compared happens to be 'A' or 'B', during the actual tests.

Unfortunately this kind of test is very much more complicated and time-consuming to perform than simple comparisons. Which is no doubt one of the reasons why they're done so rarely, and why so much confusion and gobbledegook seem to reign in hifi circles!

The experiments done by Phil Denniss and his colleagues to check the linearity of wires are certainly interesting, and I agree that one would expect an intermodulation-distortion test to be fairly relevant. But I can almost hear the subjectivist objections already: why didn't they measure at higher audio frequencies, or look for even smaller components; perhaps an IMD measurement doesn't show the kind of nastiness contributed by cheap cables, and detected by sensitive ears, etc...

I like Phil's point with regard to that 'thick wires for bass/thin wires for treble'



The circuit used in Phil Denniss's second experiment.

business. Of course the signals *will* tend to flow in all of the wires, whatever their frequency, and purely in inverse proportion to the wire impedance. As Phil points out, the fatter wires will inevitably tend to have lower impedance, and hence carry the major share of the current at all frequencies - even if you do try to bring in factors like skin effect, which to me still seems likely to be very minor at audio frequencies.

I must confess that in my discussion of the supposed 'directional' properties of some cables, I *did* forget the fact that RF directional couplers achieve the coupling of power in predominantly one physical direction, and without reliance on non-linearity. But as Phil points out himself, for such a coupler to work at audio frequencies it would have to be scaled up to a size far larger than the kind of cables we're talking about. And in any case, the cables concerned are supposed to provide better signal flow in one physical direction than the other, along the same circuit - not directional power coupling from one circuit to another.

I think one can only agree with Phil's summary about the overall situation, and the tortuous path followed by the signal on its journey from recording studio microphone all the way through to your loudspeaker. It *does* seem rather ludicrous to make such a song and dance about a few metres of wire right near the end of the journey, when you think about it...

Anyway, let's pass now to the second letter, which came from Keith Walters of Lane Cove, NSW. Keith also makes some interesting comments:

In all of the correspondence I have seen so far on this subject, nobody seems to have raised the possibility that acoustic vibration from the speakers could be somehow influencing the signal passing through said cables. Is it possible that whether you hear an improvement or not is determined by how loudly you play the music? (Or whether you were listening through headphones.)

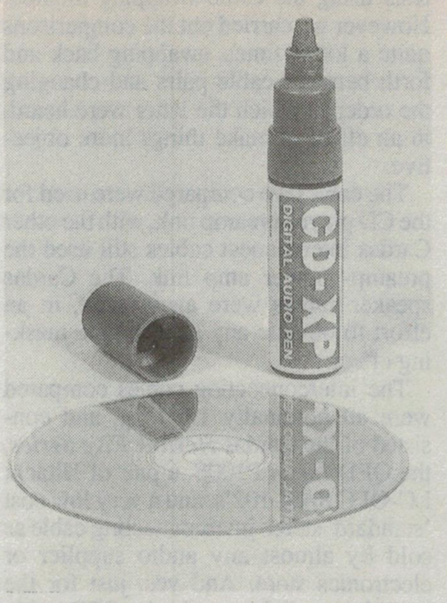
In researching the phenomenon of 'golden cables', most distortion measurements would presumably be done with the power amp running into a dummy load. I wonder if anyone has tried dangling the cables in front of the speakers, with the volume turned up, and while carrying out distortion measurements.

Among the rock music fraternity, cheap electric guitar leads are notorious for producing spurious noises if stretched or dragged across the floor. With the amp gain turned right up, draping such a lead across the speaker can produce an ear-splitting screech of feedback. Freedom from this sort of acoustic sensitivity is one of the most important characteristics of good quality musical instrument leads.

It's not too hard to imagine that a flimsy $5.00 RCA lead would be far more prone to this sort of effect than a much more solidly constructed $50.00 one. If so, while the level of feedback encountered with a domestic hifi system would be unlikely to be enough to produce sustained oscillation, it could be sufficient to produce noticeable distortion.

So maybe these cables do offer an improvement, albeit for the wrong reason! Maybe the fancy types of copper wire have an influence on this too.

Anyway, I'm still hanging out for the ultimate hifi accessory - superconducting cables, complete with their own liquid nitrogen refrigeration plant!



The CD-XP 'Digital Audio Pen', from Audio Q Imports...

Thanks for your comments too, Keith. You may well be right about the possibility of feedback via cable microphony, which presumably *could* cause distortion. But if you are, it shouldn't be too hard to *measure* this distortion. In fact it should even be possible to take a leaf out of the notebook of Phil Denniss and his colleagues, and use a two-tone IMD measurement technique to make the test more rigorous. With say 50Hz played via the speakers, and the cables carrying a non- multiple frequency around 5kHz, it should again be possible to check for IMD products - with both cheap and 'fancy' cables.

We don't have a sensitive audio spectrum analyser in the *EA* lab to try it out, or I'd give it a try. Perhaps Phil and his colleagues might help out, and let us know the result.

Our test results

As I mentioned last month, thanks to Trevor Wilson and his colleagues in the 'Oz Fi' organisation we've just had the opportunity to try out a really top-quality stereo system using mainly Australian-designed and manufactured components. The system comprised an ME 850 power amplifier and matching ME 25 preamplifier from Peter Stein's ME Sound, coupled to a pair of impressive 5-driver 'Silhouette' enclosures from Lia Galante's Port Macquarie-based firm Audio Definition. Later the AD Silhouettes were replaced with a pair of Brad Serhan's 'Dolomite' enclosures, from Orpheus Loudspeakers in Sydney.

To ensure that I could drive such up-market gear with a suitably 'ultra-clean' signal, Trevor also arranged for the loan of a Harman/Kardon HD7500 CD player. This is one of H/K's latest models, with a 'Bitstream' single-bit DAC system operating at a clock frequency of no less than 33.86MHz and a rated low level linearity of +/-0.2dB at levels down to -90dB.

In short, it was very much a top-drawer system, and capable of significantly higher definition than my existing setup. In fact it was a delight to listen to, and I'll write more about this soon in a separate article.

But as I noted last month, the relevance of this system to the present discussion is that by sheer coincidence it provided an opportunity to try out some of Mr Cardas's speaker and interconnecting cables for ourselves - and in a system with undisputably high definition. Not only that, but we were also able to compare them with standard 'el cheapo' cables, and also with cables such as those by QED and Hitachi. The very same cables tested previously and discussed in the May column, in fact.

Now before I give the test details and results, I should stress that although we tried to be as objective as possible, to get around at least some of the 'psychoacoustics' problems discussed earlier by Phil Denniss, we were not able to carry out true double-blind A-B tests. We were only able to do fairly simple A-B comparisons, using what were essentially fairly crude 'single blind' control - with only the experimenter knowing the cables in circuit and with any knowledge of the kind of result to be anticipated. So in that sense, our tests can't be judged as particularly rigorous; although I suspect that they were probably more so than many of the comparisons made in hifi stores.

The other comment that should be made is that with this kind of testing, you're listening to *extremely small* dif-

ferences in performance. Even with the top-quality system we were able to use, the differences produced by changing any of the cables were very small indeed - far smaller than those produced by changing major components like loudspeaker systems, for example. Which is what you'd expect, of course.

With the qualifications over, now for the actual tests. First the speaker cables, where we essentially compared a pair of Cardas *Hexlink Five Series* cables (overall diameter 14mm) with a pair of regular 'el-cheapo' cables, each consisting of *two* lengths of 'heavy duty' figure-8 plastic covered mains flex, with the two 44-strand conductors connected in parallel to give 88 strands of 0.16mm diameter, for each conductor. Both the Cardas and regular cables were nominally three metres long.

We did comparisons between these two kinds of cables in two different ways. One was by swapping back and forth between one pair and the other, and listening repeatedly to various pieces of music selected for (a) their excellent recording quality; and (b) their content, and its ability to show up subtle IMD effects. The other was to use one type of cable for each channel, feeding identical loudspeakers, and use the ME 25 preamplifier to mix the incoming stereo into mono, which was then fed alternately to either one power amp/speaker combination or the other, for instantaneous A-B comparisons. Again this was done repeatedly, with the same selected music segments.

And the results? To be honest, I couldn't hear any difference at all. Some of my younger listeners felt they could hear a very slight difference between the Cardas and the regular cables, using the cable-swapping method. The Cardas cables seemed slightly 'cleaner' at the extreme treble end, they thought.

But when we tried the instantaneous comparison method, switching mono signals back and forth between the two cable/speaker systems, none of us could consistently detect any difference between the two.

By the way, these tests were performed with the HD7500 CD player, ME 25 preamp and ME 850 power amp all hooked up using Cardas *Hexlink Five Series* interconnecting cables - just to make sure that there could be no arguments about masking due to poor- quality interconnecting cables. The cables between the CD and the preamp were 1m long, while the special cables used to link the ME 25 and ME 850 (because of the latter's special input sockets) were 1.5m.

For the interconnecting cable comparisons, we were only able to perform tests using the cable-swapping method. However we carried out the comparisons quite a lot of times, swapping back and forth between cable pairs and changing the order in which the latter were heard, in an effort to make things more objective.

The cables we compared were used for the CD player-preamp link, with the other Cardas interconnect cables still used the preamp- power amp link. The Cardas speaker cables were again used, in an effort to obviate any conceivable masking effect.

The interconnecting cables compared were all nominally 1m long, and consisted of the Cardas *Hexlink Five Series*, the QED *Incon* P100S, a pair of Hitachi LC-OFC SAX-102's, and a very low cost 'standard' stereo interconnecting cable as sold by almost any audio supplier or electronics store. And yes, just for the record, we tried not only the QED cable in both directions, but also the Cardas and Hitachi cables as well. This is because like the QED cables these also have little 'directional' arrows printed on their outer sleeves - even though their makers don't seem to make any claims about directionality.

The results were a *little* different from those with the speaker cables, but still not dramatic.

Our younger listeners found the sound with the standard cables slightly 'flatter' or 'deader' than with ANY of the fancier cables. They tended to find the sound produced with *all* of the fancier cables more 'alive' and 'crisper' than with the standard cables, in other words. But there were no consistent differences found between the Cardas, QED and Hitachi cables, connected either way around in each case.

Personally, I thought that I too could hear a slight difference between the standard cable and the others. It did seem a little *flatter*, but I'm still not sure I wasn't kidding myself.

I think one thing did become clear, from all of this. The differences produced by the various types of cable were extremely subtle, and may well not be even audible with systems using primary components of lower resolution.

What else can one conclude? Not a great deal, I suspect, except that if you already own a system where the main components are all top-of-the-range items, and you still have money to spare, there's probably no harm in investing in some of these fancy and expensive cables. You may even be able to hear a slight improvement.

But if you're more like most of us, with a fairly average system and budget, my strong impression is that you'll hear a much bigger improvement if you spend any available money on upgrading your speakers and power amp, in that order.

Sorry Mr Cardas, but your cables didn't really make much more impression on me than your explanation of the way they work.

Magic pen?

Here's a little something to think about this month, before I end up. It's not about fancy cables, but a related topic: gadgets claimed to obtain improved performance from your compact discs.

A couple of weeks ago I received a small parcel from Vincent Tester, who runs a company called Audio Q Imports in Hawthorn, Victoria. The parcel contained a special 'CD-XP Digital Audio Pen', which looks like a fairly fat felt marking pen containing a dense green ink, together with instructions and literature on the way it's said to work.

The basic idea is that in a CD player, some of the infra-red light from the pick-up layer can be diffracted and/or reflected sideways in the disc material. Here it can travel out to the sides of the disc, where it can be reflected from the edge and hence can return (delayed) to the pits being read, to cause potential reading errors. So by applying a dense green coating to the edge of the disc with the CD-XP pen, to absorb the stray infra-red, it is prevented from returning and causing trouble - resulting in noticeably 'cleaner' reproduction.

It might sound a bit far-fetched, perhaps, but I decided to try it out while I still had access to the you-beaut Oz Fi system. And what do you think?

That's right, I reckon I *can* hear a difference. Somehow the coating from the pen seems to remove a subtle 'edginess' from the sound - an edginess that in some cases I wasn't even conscious of, previously. Somehow the music now seems 'cleaner', at least with *some* discs. Other discs didn't seem to respond at all, and I suspect that's because their aluminisation extends around the outer edge, and stops the green stuff from working.

Perhaps I'm imagining things, and having myself on - Phil Denniss's psychoacoustics run rampant? I'll certainly try doing some more testing before next month.

But note that the cost of the CD-XP pen is only about $10-12, and so far it seems to produce at least as much improvement to the sound from some of my CD's as certain fancy cables costing much, much more. How embarrassing!

Incidentally Audio Q Imports' address is 649 Burwood Road, Hawthorn 3122; phone (03) 813 3691. ●

eti

ELECTRONICS • TECHNOLOGY INNOVATION

OCTOBER CONTENTS

TI'S ADVANCED SUPPORT SYSTEM FOR EMULATION, TESTING

ETI Construction Project:

Simple 'extra supply rail' generator

Applications abound where an 'extra' supply rail is needed – TTL/RS232 interfaces and EPROM programmers are but two examples. The simple ringing choke converter provides an ideal solution, but to most would-be constructors, their design is tantamount to black magic. C.J. Pitcher clears the fog.

There are many occasions when a circuit calls for more than one supply rail – to power a TTL/RS232 interface from a 5V logic supply, supply the programming voltage for EPROMs, or obtaining an extra supply rail when mixing digital logic with communication circuitry. Not-so-obvious applications are battery supplied equipment, where efficiency and/or performance would otherwise have to be compromised to suit available battery voltage, and RF power transistor circuitry, where efficiency and gain usually dramatically improve at a supply rail just above the one you have available!

Most of these applications can be sorted out by fitting multiple regulators. If the equipment is mains powered, then multiple unregulated rails are easy to generate – although several transformers may be necessary. There are times, however, when none of these solutions is convenient, and then the average junk box can yield a simple solution, namely – a *ringing choke converter*.

Now most people at this point throw up their hands in horror, remembering a design procedure akin to black magic and the soft *phutt!* that a transistor makes as it blows up. But take heart; that same black magic can work for us, and once the beast is correctly set up, transistors tend to chug away cheerfully without further complaint.

The bare bones

Stripped of details, a ringing choke converter looks like Fig.1. The transistor is biased so that a collector current flows through the primary winding when power is switched on. The secondary winding is connected so that feedback is positive, i.e., collector current increases cause base current increases, and vice versa.

So at switch-on, the small initial collector current quickly causes a large collector current, so that the transistor saturates. Inductors, however, take their time over current build-up, so the nett effect is a slowly increasing current in the primary winding, with the rate of rise determined by the value of its inductance.

The transistor will saturate, beyond which the current the inductance allows to flow exceeds the current the transistor can support, and the transistor comes out of saturation. This causes the collector voltage to rise, which causes the base current to fall, and the transistor rapidly switches off. The inductance, feeling cheated, looks elsewhere to dump the current it is now carrying (the field built up in the core collapses); the only place it can go is through the diode and into the output capacitor. Then the whole process starts over, so the circuit oscillates.

Depending on a variety of factors, that capacitor can be charged to a higher voltage than the input supply. The circuit is then acting as a voltage converter. (Some describe it as a DC transformer).

What determines the output voltage? To a first order, only the loading on the output capacitor. If that load is low, then the output can get very high indeed, which is one of the reasons for the nasty reputation this circuit has for blowing up transistors. There are ways around this problem, as we shall see, but remember: don't ever run such a circuit without a load if you value your transistors, and for that matter, if you prefer not to get zapped every time you touch it!

Various refinements of the circuit are seen. The output voltage need not be simply taken off at the collector, although that is the simplest. A separate winding can be used, or the collector can be tapped down the primary. The output can be applied to a voltage multiplier, although with the usual mark/space ratio that tends to lower the efficiency.

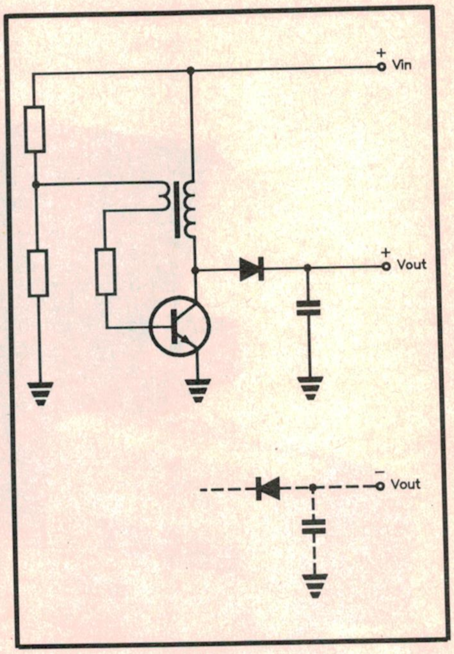
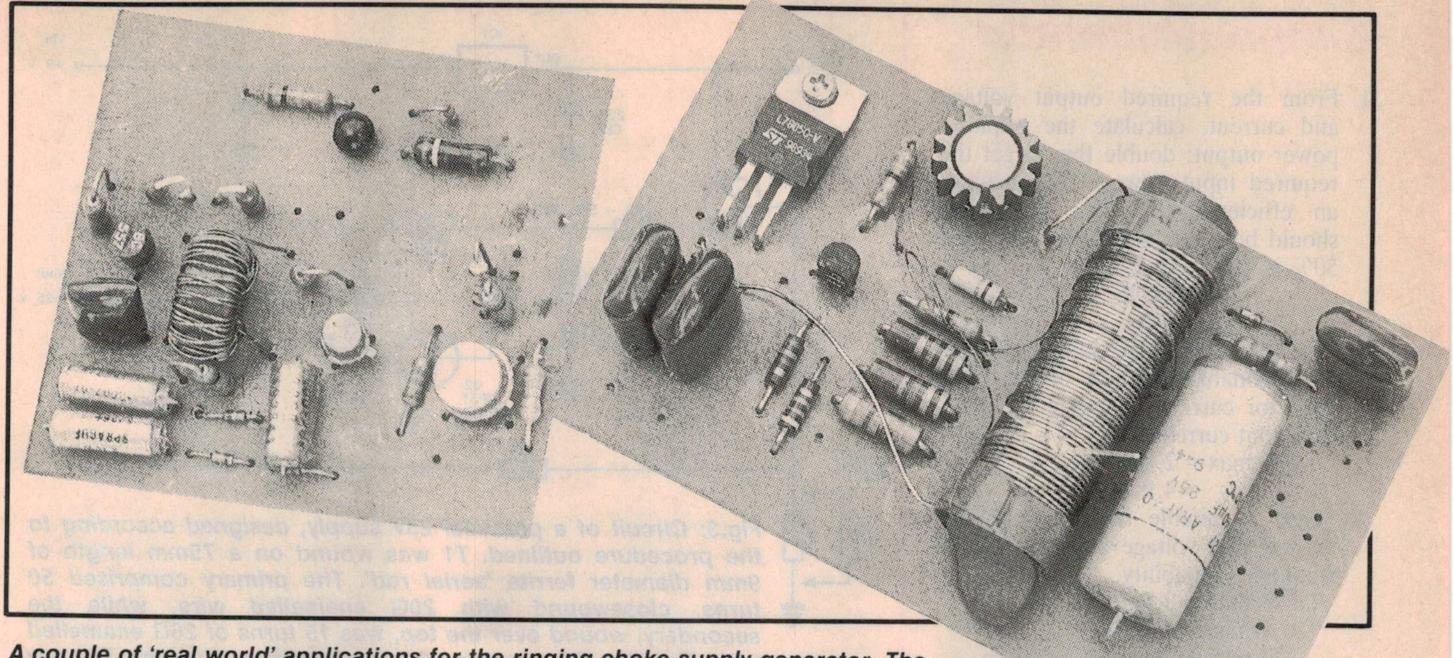


***Fig.1:* General form of the ringing choke supply generator. How it works is explained in the text. A negative output is obtainable simply by reversing the diode, as shown.**



A couple of 'real world' applications for the ringing choke supply generator. The larger board is a 25V supply for an EPROM programmer that runs off a 9V supply, while the smaller one is a TTL-RS232 interface that supplies split rails and runs off a single 5V supply. (Yes, I know about the Maxim chips for this job, but my solution's a whole lot cheaper – if less elegant!)

Component notes

The output diode must be able to withstand the output voltage, as must the output capacitor. The diode must also be able to work with a short current pulse, although that is true of all power supplies.

The resistance in series with the transistor's base is a compromise; it should be a large enough value so that the maximum collector current is well defined, but at the same time it should be low enough in value so as not to waste power. And, more importantly, it should be of such a value that the base-emitter breakdown voltage of the transistor is not exceeded. It is usually best adjusted experimentally, although it's not particularly critical; also it may have to be increased when regulation is added, of which more anon.

The transformer is actually one of the least critical components, at least if you are not after the ultimate in efficiency or a tightly controlled operating frequency. Most ferrite materials – rods, toroids, potcores, etc – can be pressed into service after a fashion. I have used toroids, rods and the cores from TV horizontal output transformers, as well as the more conventional potcores.

For various reasons, iron cored inductors such as the output transformers from transistor radios, tend to be disappointing; in most cases the wire is too fine, and I lack the patience to rewind them. It is best if the core has an air gap to avoid problems with saturation, again because the efficiency usually drops. Potcores, rods and such are therefore usually a better choice than toroids.

In fact, part of the magic of this circuit is that it is *very tolerant*; gross errors and simplifications in design have a relatively minor effect on performance. It is, in fact, well suited to throwing together from odd parts – to meet that particular oddball requirement that tends to turn up with depressing regularity.

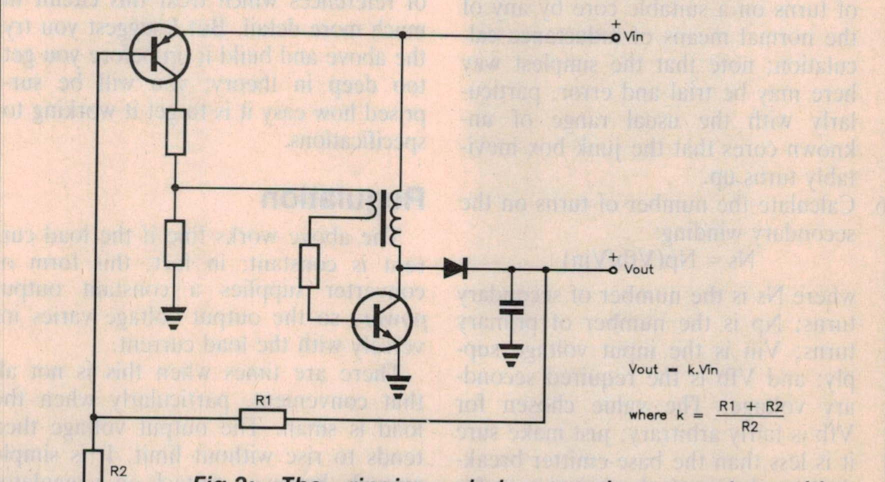


Fig.2: The ringing choke supply generator with regulation added. The output voltage is determined by the ratio of (R1 + R2) to R2.

Contributed by The Apogee Group

Design procedure

Warning – what follows here is vastly simplified. But it is effective, as I've proved in practical circumstances. Here are the steps:

Simple Generator

1. From the required output voltage and current, calculate the required power output; double this to get the required input power. This assumes an efficiency of 50%; the result should be a lot better than that, but 50% is a safe worst case.
$$Po = Vo.Io$$
$$Pin = 2.Po$$
2. This gives the input supply current. A reasonable estimate of the peak collector current is double the average input current.
i.e., $Icmax = 2.Iin$
$= 4.Po/Vin$
3. Select a suitable transistor for this current and voltage and estimate its frequency capability.
i.e., $Pcmax = 2.Po$
$Icmax = 4.Po/Vin$
$Vcmax = Vo$ (plus a margin for safety)

   There are various ways of estimating the transistor's frequency requirements. They are not all that critical, the main impact of a 'too slow' transistor (low fT) being lower efficiency. A rule of thumb is that the efficiency starts to get uncomfortably low at a frequency of around fT/10.
4. Calculate the required primary inductance. By making some wild approximations we come up with the following equation:
$$Lp = Vin/(8.Po.f)$$
where Lp is the primary inductance; Vin is the input voltage supply; Po is the required output power; and f is the required frequency (pulse repetition rate).
5. Turn this into the required number of turns on a suitable core by any of the normal means of inductance calculation; note that the simplest way here may be trial and error, particularly with the usual range of unknown cores that the junk box inevitably turns up.
6. Calculate the number of turns on the secondary winding:
$$Ns = Np(Vfb/Vin)$$
where Ns is the number of secondary turns; Np is the number of primary turns; Vin is the input voltage supply; and Vfb is the required secondary voltage. The value chosen for Vfb is fairly arbitrary; just make sure it is less than the base-emitter breakdown voltage of the transistor; for various reasons 1 – 2V seems close to optimum.
7. Calculate the series base resistance:
$$Rb = Vfb\ (Hfe/Icmax)$$
where Hfe is the AC gain for the transistor, remembering that we want it to be well saturated. A suitable figure is usually around 10 – 20.

Now those of a more analytical frame of mind are probably having convulsions at this point, over the gross simplifications made in the above. I agree, the results will vary wildly. But *the resulting converter will still work*, and probably almost as well as if a great deal more time had gone into the design. I prefer to spend that time doing other things.

If you are really uncomfortable with this approach, there are quite a number of references which treat this circuit in much more detail. But I suggest you try the above and build it up before you get too deep in theory; you will be surprised how easy it is to get it working to specifications.

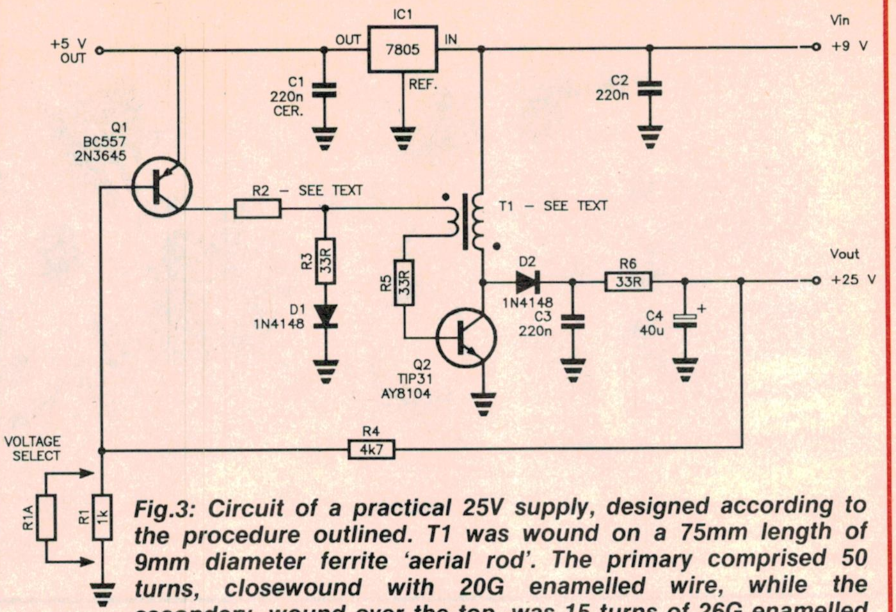


Fig.3: Circuit of a practical 25V supply, designed according to the procedure outlined. T1 was wound on a 75mm length of 9mm diameter ferrite 'aerial rod'. The primary comprised 50 turns, closewound with 20G enamelled wire, while the secondary, wound over the top, was 15 turns of 26G enamelled wire. Resistor R2 was two 430-ohm resistors in series, but any other two resistors making up a like value could be used (like 820 and 39 ohms). The spots near T1 indicate the start (or finish) of the respective windings.

Regulation

The above works fine if the load current is constant; in fact, this form of converter supplies a constant output *power*, so the output voltage varies inversely with the load current.

There are times when this is not all that convenient, particularly when the load is small. The output voltage then tends to rise without limit. It is simple enough, however, to tack on a regulator which adjusts the base voltage – and hence the base current, collector saturation current, and hence the output voltage.

See Fig.2. Here, a fraction of the output voltage is 'sampled' by the resistive divider R1-R2, and this is compared with the input supply (or a reference supply if the input isn't stable enough). The output of this comparison is used to control the oscillator transistor's base bias via the PNP transistor. This gives more than sufficient regulation for most purposes. If better regulation is needed, it is usually simpler to add a three terminal regulator to the output.

If this circuit loses regulation, particularly at low voltages, it is usually because the secondary is coupling too high a voltage to the base circuitry and/or the base resistance is too low; reducing the number of turns on the feedback winding usually brings it back into line. It may seem obvious, but you would not be the first to try and regulate the output voltage to below the input supply!

Results

Fig.3 shows the circuit of a converter I have built several times over, for supplying 25V at 35mA from a 9V rail for an EPROM programmer. It was 'designed' (with apologies to the purists for using that word) along the lines just described. As always, it is capable of improvement. (At my place, if it does the job then it gets no more attention).

In one effort, the transistor was a TO-5 silicon device from which the markings had long disappeared; my estimate is that it had an fT of around 5MHz,

and the BVcbo was better than 40V.

Calculations suggested that for a frequency of 100kHz the primary inductance should be around 120 microhenries. I wound 50 turns on a three-inch length of loopstick from an old transistor radio, with a 15-turn secondary (20 in another instance). The primary inductance of this arrangement was later measured at around 150 microhenries.

Judicious adjustment of the 'sampling' resistors (R4, R1-R1A) gave an output voltage of 25.2V no load, falling to 25.1V with 75mA output current. For 25V out, R1A is 2.7k. For 28V out, R1A is 2.2k. With no load, it drew about 50mA from the 9V rail, rising to 180mA with a 680-ohm load resistor; this represents an efficiency of 57.5%, which is a bit low, but adequate. The transistor got a bit warm, but a clip-on heatsink calmed it down.

I found a pot-core while grubbing in the junk box which looked interesting, so I wired it in temporarily. The frequency dropped to a bit under 10kHz, and the efficiency shot up to 85%, which suggests that a lot of the loss is due to the transistor switching speed. This was a 25mm core of 3H1 material, with an estimated 70 primary turns; I wound about 15 turns on top as a secondary.

Going further

Of course, you may want to turn the above procedure on its head. You may have a ready made inductance; in that case you need to select a transistor to suit, and live with the resulting frequency. No matter, it still works.

Bear in mind that the choice of diodes becomes limited as you raise the frequency, particularly if you want a lot of power out. Most power rectifiers start to seriously limit the efficiency above about 20kHz. Small signal diodes such as the 1N4148 work at frequencies a lot higher, but at lower currents. If your power requirements are that high, it is probably worth looking at a push-pull converter with a proper saturating core transformer, but that is a horse of a rather different colour.

Some of the places where this circuit is currently installed include a breakdown voltage meter, where the device is a 2N964 mesa switch and the transformer a rewound miniature IF transformer; this runs at about 250kHz, to give a voltage pegged at around 120V. Another is to run an op-amp in a high impedance meter, which runs off 30V supplied from two penlight cells (using a TIP31 and an unlabelled potcore, running at about 30kHz). ●

Keeping tabs on the UV bogey

Jack Middlehurst reviews a locally designed and manufactured instrument that can be used to measure levels of UV radiation in all sorts of applications, ranging from sunbathing to photo-resist exposure.

The Sun emits massive amounts of energy, in various forms including electromagnetic radiation that has a frequency range from below the Ultra Low Frequency (ULF) range up to the frequency of light, then on to ultraviolet (UV) light and beyond.

We humans would not exist in our present form if most of this barrage was not absorbed by various processes that take place in the upper atmosphere. Life on Earth is particularly sensitive to the level of UV radiation at ground and sea level. Considering the amount of media coverage about the ozone layer and holes therein, and the effects of this on the incidence of melanoma (skin cancer), there can't be many people who haven't heard of UV light and its effects on humans.

As the colour of light changes from red through orange, yellow, green, blue, to violet, the frequency and consequently the energy and penetrating power, of the radiation increases. The frequency of violet light ranges up to 750THz (terahertz), i.e. 750 million megahertz, corresponding to a wavelength of 400nm. Above this is ultraviolet light, divided for convenience into UV-A and UV-B. UV-A goes from 750 to 938THz (400 to 320nm) and UV-B goes from 938 to 1071THz (320 to 280nm). Above this lies UV-C, then soft X-rays, hard X-rays, gamma rays and finally cosmic rays, although the sun does not emit much of the latter.

Since, in rather general terms, UV-A allows many of us to get a tan, but the more penetrating UV-B gives us sunburn, skin damage – and if you are unlucky, skin cancer – it would be nice to have a meter that would allow us to measure the levels of UV-A and UV-B before we venture out for a bit of sunbathing.

It would be better still if, for example, the daily meteorological predictions included information on the likely UV levels, in much the same way as we get information on expected temperatures. It was to provide a suitable instrument for this purpose that the Zeta Heliometer (from helio – meaning the Sun) was designed.

Background

The instrument was conceived by Stephen Bathgate, working in Drummoyne NSW, and we were able to get one of the first production models. The basis of the instrument is simple; an ultraviolet-sensitive detector is coupled to a bridge amplifier, the output of which goes to a 3.5-digit panel meter. The whole thing runs off a 9V battery. It is the thoroughness of the design that impresses with this instrument.

Almost any energy detector will detect energy not only in the frequency range in which you are interested, but also at frequencies *outside* the range of interest. So simply connecting a detector to a meter is not good enough. In front of the detector in this instrument is a filter that removes the effects of ordinary light, as well as infra-red radiation – both of which occur in copious quantities in sunlight.

Having managed to get the meter so that it is only sensitive to UV, the next problem is how to calibrate it in practical units. In this case, Stephen solved the problem by engaging the services of the National Measurement Laboratory at Lindfield NSW. Once accurately calibrated, the first meter can be used, together with a suitable source of ultraviolet light, to calibrate all subsequent meters.

The meter that we received claims to cover the range from 290 to 380nm and had been calibrated at a wavelength of 365nm. The digital meter scale is calibrated directly in watts/square metre. This calibration is approximate, since a full calibration would require calibration over the whole frequency band of the instrument. However, for the purpose for which the meter is intended, this spot calibration is entirely adequate.

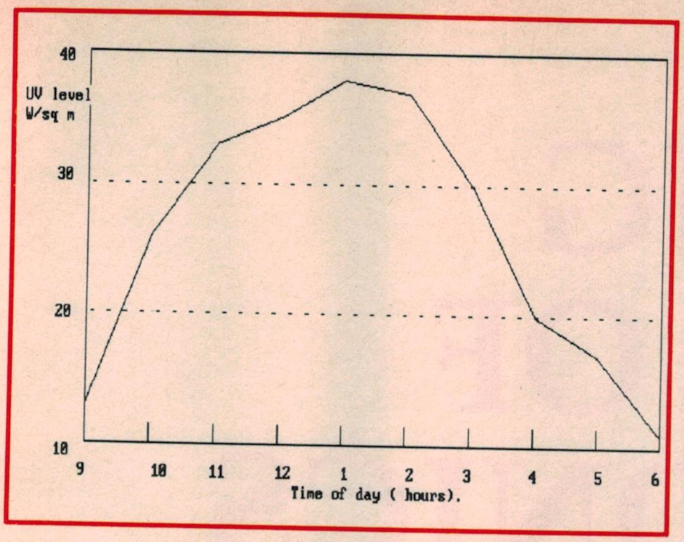
UV-A is used in a large number of industries for purposes such as curing and cross-linking of plastics, and environmental testing of materials. The American standard for acceptable levels of UV-A in the workplace is 16 minutes per day at an energy level of 10 watts/-square metre. Because of the considerable variation in skin types, this figure can only be taken as an indication; your own personal tolerance may vary by a factor of five (5), up or down from this level.

Since the price of the meter is about $700, it is clearly not intended for the mass market. But, in addition to the meteorological people, it is directed mainly at Government departments and industries (e.g., paint companies) who have a vested interest in knowing ultraviolet levels.

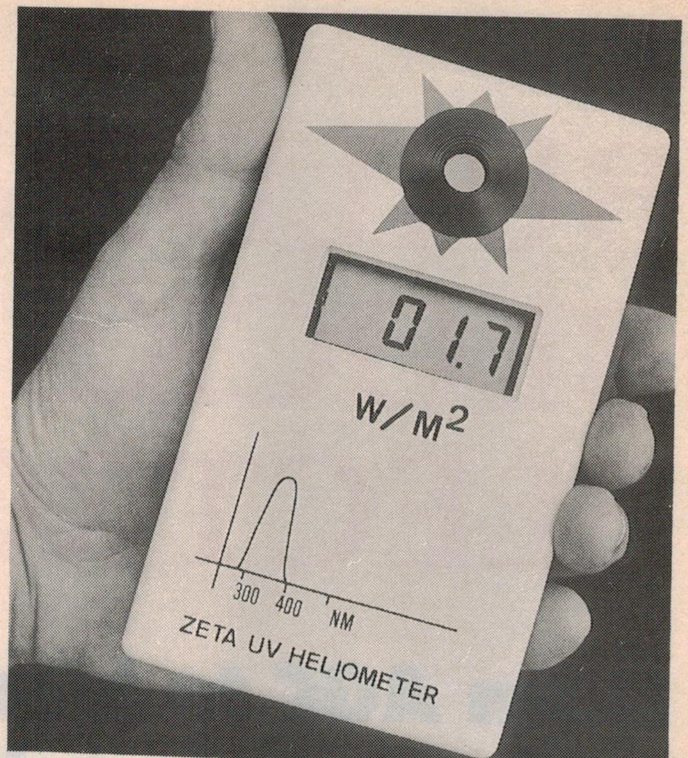
Since we were testing the heliometer in February during the floods on the eastern coast around Sydney, exposing it to the Sun presented something of a problem since there wasn't any! So we were forced initially to use it indoors.

On test

The correct instrument to use for testing a heliometer is a scanning UV spectrophotometer. Since we don't happen to have one, and Sydney's universities and CSIRO were reluctant to let us



(Above) Fig.1: UV levels (Watts/m^2) on Friday 16th February 1990, measured using the Zeta UV Heliometer.



(Right) The Zeta Heliometer, an Australian designed and made instrument for measuring ultraviolet radiation in the UV-A and UV-B portions of the spectrum.

modify theirs to fit the heliometer into them, we were reduced to simpler, but nevertheless adequate, testing methods.

Pointing the heliometer at a 150W Paraflood lamp produced no response, confirming that the heliometer is not sensitive to infrared radiation. At 50cm from a bank of standard fluorescent lights the reading was again zero, showing the lack of sensitivity to ordinary light. At a range of 50mm from the lights the reading was 0.2W/m^2, which is almost certainly caused by the small amount of UV that is emitted by ordinary fluorescent lights.

Exposure to a UV fluorescent lamp produced an immediate reading of 6.4W/m^2. These tests convinced us that the heliometer is indeed sensitive to UV light and not to ordinary light or infrared.

Still indoors, one of the immediate uses to which we put the meter was to measure the level of UV in our system for exposing PC board photoresist. The meter is moderately directional, so we were able to scan across the whole area looking for variations.

Our system consists of a number of Philips special UV fluorescent lamps and produced an average reading of 5.7W/m^2, a UV energy level similar to that of sunlight on a moderately overcast day. The energy level dropped quite sharply near the edges of the illuminated area, which correlated well with our experience in using the exposure system.

For major users of photoresist, having such a meter as a check on the level of illumination on the boards would save losing production when the UV source starts to deteriorate, which is something that can't be detected by eye. Exposure times could simply be lengthened as the UV level falls.

Once the Sun did finally put in an appearance, we measured the level of UV at hourly intervals on a day with only a moderate amount of high cirrus cloud. This gave us the curve shown in Fig.1. Note that at our location, readings could not be taken before about 8:30am, since the Sun is behind a ridge up to that time during February.

You can see that for most of the day, a 15 minute exposure would considerably exceed the safe industrial level. Remember that the safe level is intended to be just that, i.e., *safe*. You are not supposed to be getting a free tan at work where UV is used! So to avoid the chance of melanoma, the use of UV blocking creams or oils would be essential on a day such as the one on which we took the measurements.

Of course, we couldn't resist the temptation to try out a few sunscreen lotions. Since we are not really in the business of testing these things, we will only report that a single sheet of Gladwrap onto which we smeared the lotions reduced the reading in bright sunlight by 10%. The lotions that we tried gave a further reduction that varied from 15% to 80%.

Summary

Overall we were impressed with this meter. Its designer has obviously done his homework, and has given us a meter that is soundly based and avoids the pitfalls into which some of the earlier designs have fallen. Perhaps you could persuade your company to buy one and then borrow it and check your sunscreen lotion, the reflecting film on your car or home windows, the 'UV absorbing' plastic over your patio, your PC board exposure system or whatever.

We look forward to the day when the Bureau of Meterology will give us predicted ultraviolet radiation levels as part of its daily bulletins, using information derived from a meter such as this. Perhaps, as well as this, each major beach could have a meter and display the UV level on a large screen or display, so that sunbathers could see it.

It would be even better if, despite the considerable cost of the special UV detector and filter, the price of the instrument could be brought within reach of consumers so that we could all know the UV level in our own backyard and clothe ourselves and our children appropriately.

Further information on the Zeta Heliometer is available from Zeta Electronics, PO Box 342, Drummoyne 2047 or phone (02) 81 4805. •

BUILDING BLOCKS OF ELECTRONICS

From AGC to blocks with multiple active devices

Jack Middlehurst wraps up radio receivers with coverage of automatic gain control circuitry, then looks at circuit blocks which employ two or more active devices.

Early valve radios, before superheterodynes had manual control of the radio frequency gain, often using a variable resistor in the aerial lead. Once superheterodynes were introduced, *automatic gain control* or AGC (sometimes called automatic volume control, or AVC) became essential, since the overall gain of the receiver was made high to get good sensitivity to weak signals, and this led to overloading on strong signals.

All automatic gain control systems measure the signal level somewhere in the receiver and use DC negative feedback to keep that signal level as constant as possible.

In valve receivers, standard practice is to use the fact that the RF detector that produces the audio signal from the modulated IF signal also produces a DC output proportional to the average level of the IF signal level. The audio output is the same whether the diode detector is connected for positive or negative output, so by making the diode produce a negative DC voltage a suitable control voltage is available.

This negative voltage is applied to the control grids of the IF stages, the RF stage if any, and often to the frequency converter as well. If the signal at the detector increases, the DC voltage at the detector gets more negative; the more negative the AGC voltage, the more the gain of the IF stages is reduced, tending to bring the detector voltage to its original level. A typical circuit block is shown in Fig.11.1.

More elegant radiograms boasted combined broadcast/shortwave receivers, in which the AGC voltage to the RF amplifier is 'delayed'. This simply means that AGC voltage is applied to the IF stages at all times, but no AGC voltage is applied to the RF stage until the IF signal at the diode reached a certain voltage, usually 1V RMS. In this way, the RF stage is operated at maximum gain for small signals, giving optimum signal-to-noise ratio.

The circuit for such an AGC system is given in Fig.11.2. The delay is induced by putting a fixed voltage of +3V on the cathode of the second AGC diode. This means that the diode will not conduct

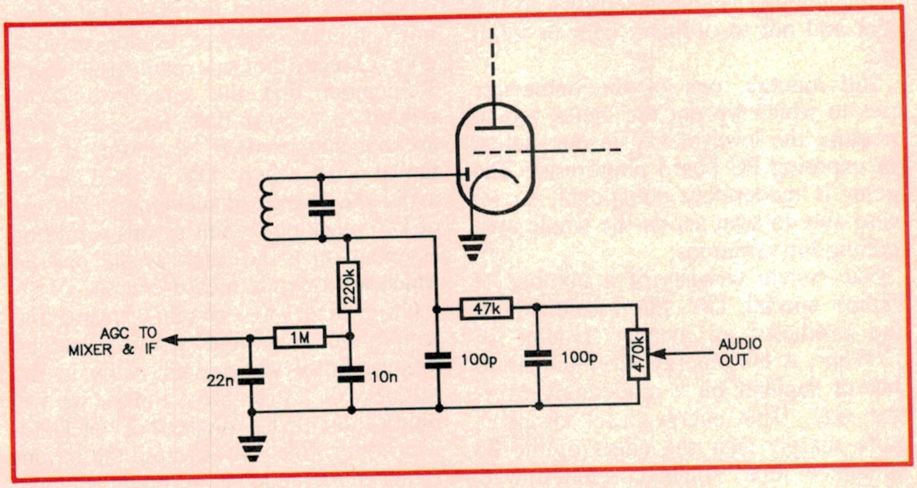


Fig.11.1: Typical AGC circuit for valve AM radios.

until the anode voltage is more than 3V, which means that no AGC voltage is developed by this diode until there is about 2V RMS of IF signal on the diode.

For transistor radios, the principle of automatic gain control is the same as for valve radios. The differences are that controlling the gain of a transistor requires power, so the resistance values in the circuit have to be lower, the DC voltage often has to be positive, and the positive voltage may need to decrease with increasing IF signal.

Applying delayed AGC to an RF stage is easier, however, in that a zener diode (or a string of semiconductor diodes) can be used to prevent any AGC current reaching the RF stage until the AGC voltage exceeds the zener threshold. A block diagram of the type of circuit needed to accomplish this is shown in Fig.11.3. The zener does not conduct until the AGC voltage exceeds +1.3V, so the RF stage is operating under best signal-to-noise conditions until the incoming signal is greater than about 1mV.

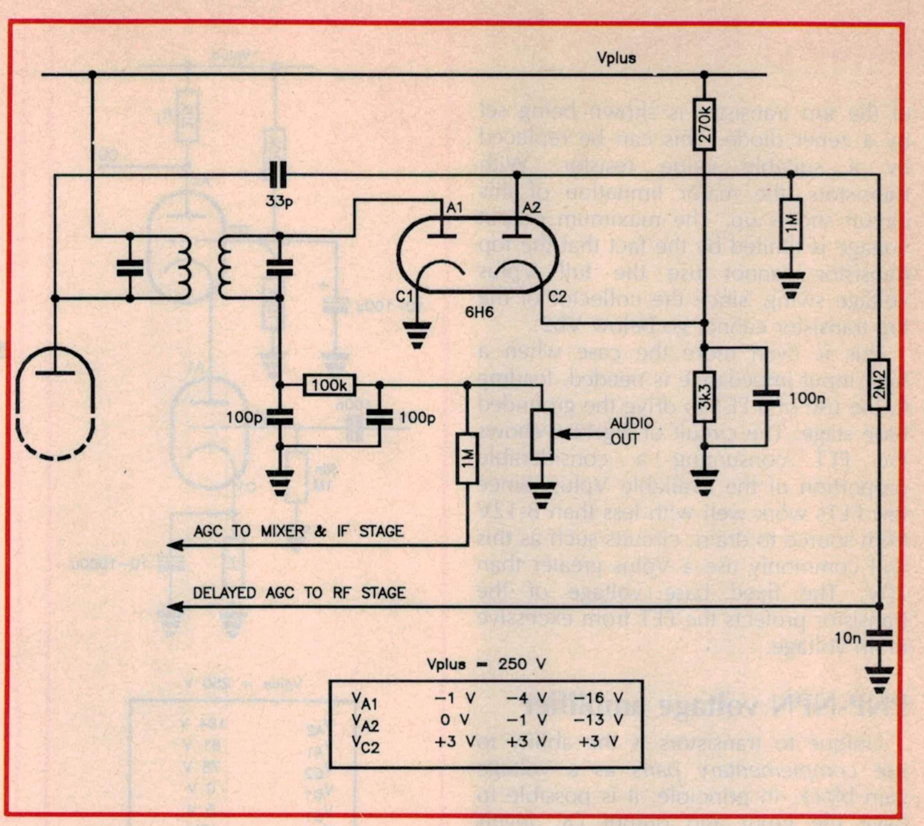


Fig.11.2: Valve AGC system with 'delayed AGC' applied to the RF stage.

Blocks using two or more active devices

While many circuit blocks need only one active device, there is more scope available for cleverness when two or more active devices are used.

With transistors, particularly in DC coupled circuits, the complementary nature of PNP and NPN transistors can be exploited, leading to powerful circuit performance with a low parts count. Again, we start with valve circuits.

The cascode wide range voltage amplifier

For wideband, low distortion applications, the *cascode* circuit is an excellent circuit block. Fig.11.4 shows that this circuit is constructed by using a *grounded-grid amplifier* as the load for a simple triode amplifier. The low input impedance at the cathode of the grounded-grid stage means that there is very little signal voltage on the anode of the bottom triode, so the effect of grid-to-anode capacitance is reduced. Because of this and the screening effect of the grounded grid, the isolation between input and output is extremely good.

The overall gain of the circuit is the same as for one triode, but the stability is excellent and the bandwidth is improved from about 20kHz to more than 2MHz. Valves such as the 12AT7 and ECC88 are often used in this way in high fidelity valve amplifiers where considerable overall feedback is applied.

The equivalent transistor circuit is shown in Fig.11.5. The bias for the base

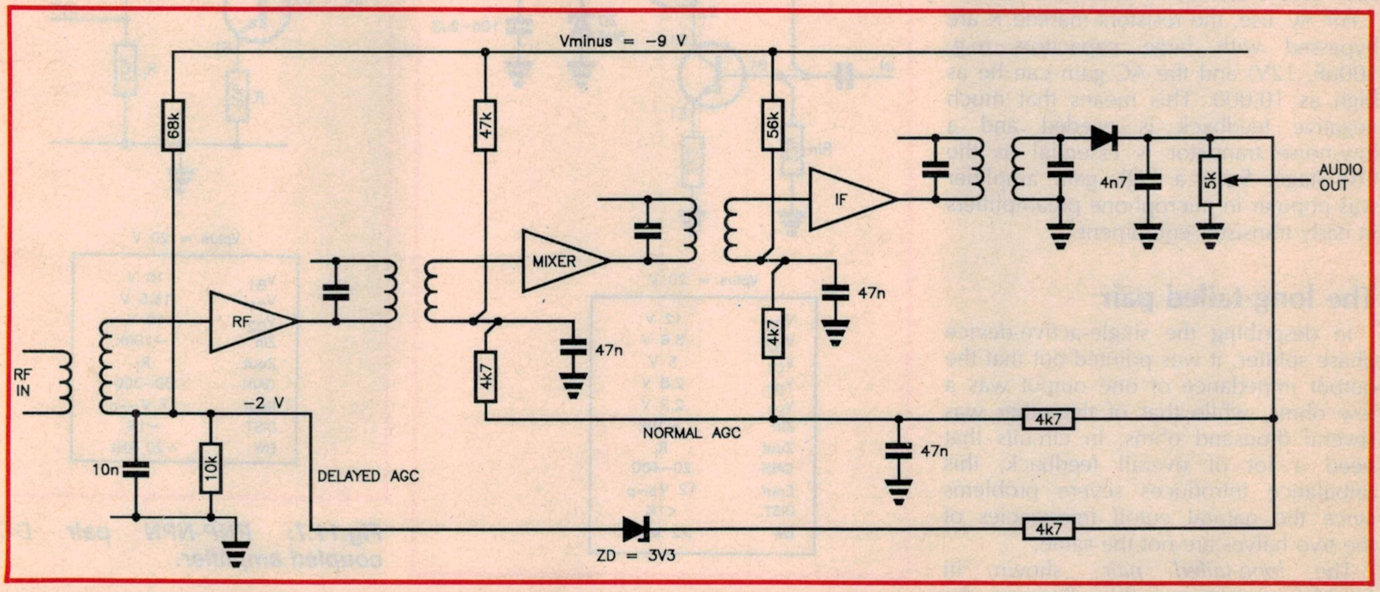


Fig.11.3: Typical semiconductor AGC system.

of the top transistor is shown being set by a zener diode. This can be replaced by a suitable value resistor. With transistors, the major limitation of this circuit shows up. The maximum output voltage is limited by the fact that the top transistor cannot use the full Vplus voltage swing, since the collector of the top transistor cannot go below Vb2.

This is even more the case when a high input impedance is needed, leading to the use of a FET to drive the grounded base stage. The circuit of Fig.11.6 shows the FET consuming a considerable proportion of the available Vplus. Since few FETs work well with less than 8-12V from source to drain, circuits such as this will commonly use a Vplus greater than 20V. The fixed base voltage of the transistor protects the FET from excessive drain voltage.

PNP-NPN voltage amplifier

Unique to transistors is the ability to use *complementary pairs* as a voltage gain block. In principle, it is possible to have the input and output DC levels identical, so that these blocks can be strung together *ad nauseum*. In practice, since there is no DC negative feedback to stabilise the DC levels, the output DC level tends to drift, so it is rare to see more than two such blocks in series.

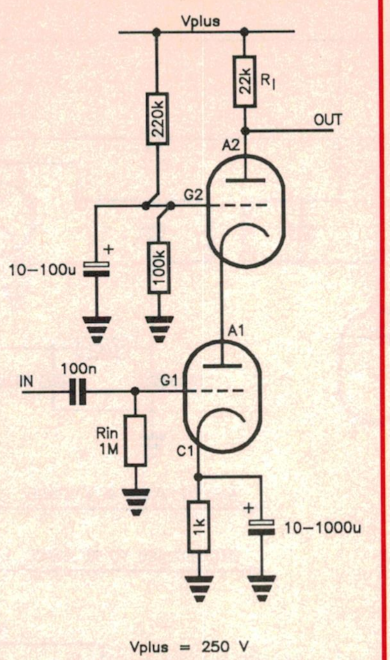
The circuit shown in Fig.11.7 is typical. In some cases one or both of the resistors marked as R can each be replaced by a string of diodes or a suitable zener diode. In this case the DC gain can be as high as 10,000, so such a circuit is always used in a feedback loop to stabilise it. Because of drift problems, such blocks cannot be used in series.

For AC use, the resistors marked R are bypassed with large capacitors (e.g. 100uF, 12V) and the AC gain can be as high as 10,000. This means that much negative feedback is needed and a low-noise transistor is essential as the first stage. Such a high gain amplifier was popular in microphone preamplifiers in early transistor equipment.

The long-tailed pair

In describing the single-active-device phase splitter, it was pointed out that the output impedance of one output was a few ohms, while that of the other was several thousand ohms. In circuits that need a lot of overall feedback, this unbalance introduces severe problems since the natural cutoff frequencies of the two halves are not the same.

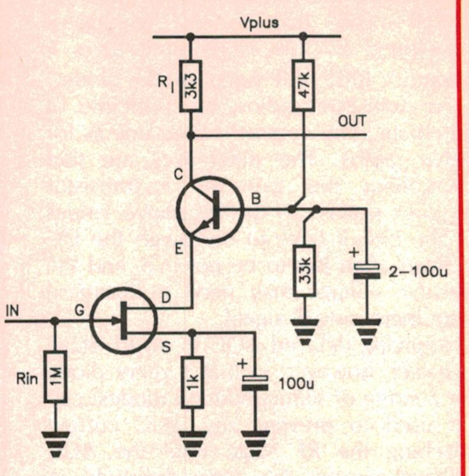
The *long-tailed pair*, shown in Fig.11.8, overcomes this. Because the circuit is symmetrical, the two output



Vplus = 250 V

V_{A2}	184 V
V_{A1}	81 V
V_{G2}	78 V
V_{G1}	0 V
V_{C1}	3 V
Zin	Rin
Zout	~7k
GAIN	5–20
Eout	30 Vp–p
DIST.	<1%
BW	>2 MHz

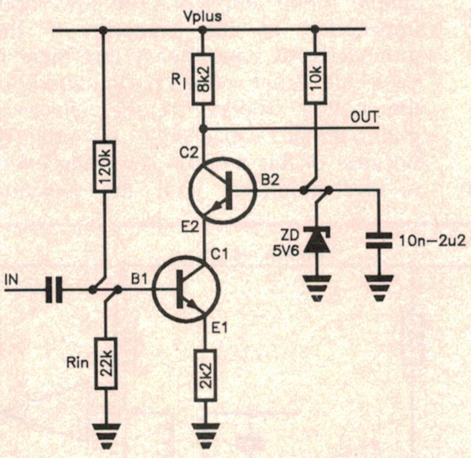
Fig.11.4: Valve cascode circuit.



Vplus = 30 V

V_C	20 V
V_D	12 V
V_S	3 V
V_G	0 V
Zin	Rin
Zout	R_l
GAIN	20–400
Eout	14 Vp–p
DIST.	<1%
BW	>2 MHz

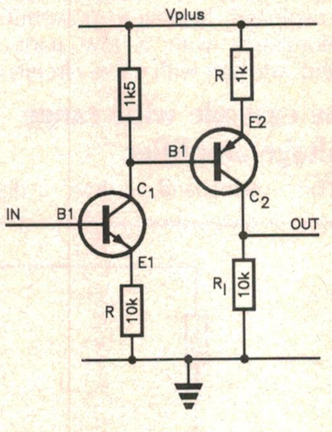
Fig.11.6: Transistor/FET cascode circuit.



Vplus = 20 V

V_{C2}	12 V
V_{B2}	5.6 V
V_{C1}	5 V
V_{B1}	2.8 V
V_{E1}	2.2 V
Zin	~10k
Zout	R_l
GAIN	20–400
Eout	12 Vp–p
DIST.	<1%
BW	>2 MHz

Fig.11.5: Transistor cascode circuit.



Vplus = 20 V

V_{B1}	10 V
V_{C1}	18.5 V
V_{C2}	10 V
Zin	~100k
Zout	R_l
GAIN	50–300
Eout	17 Vp–p
DIST.	~1%
BW	~20 kHz

Fig.11.7: PNP-NPN pair DC coupled amplifier.

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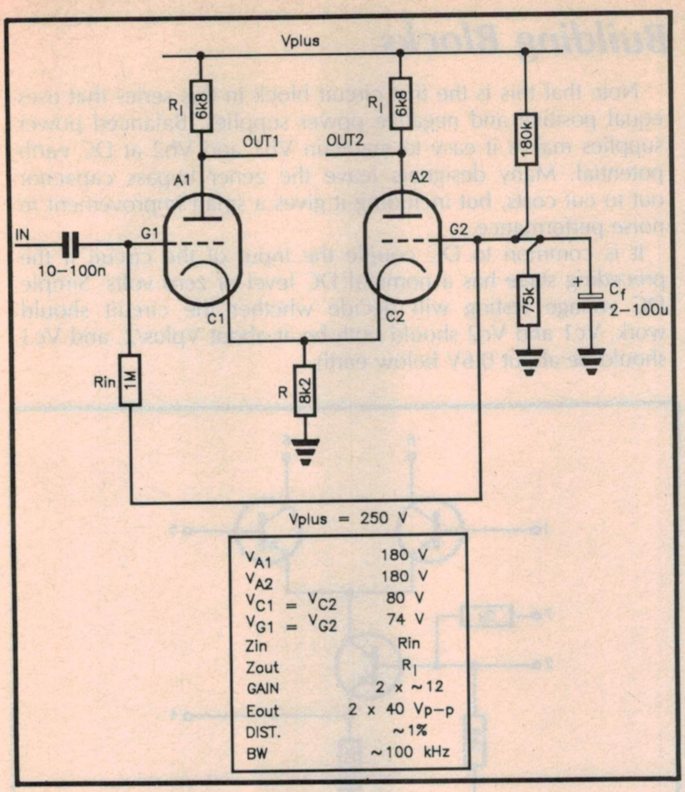

Fig.11.8: Valve long-tailed pair.

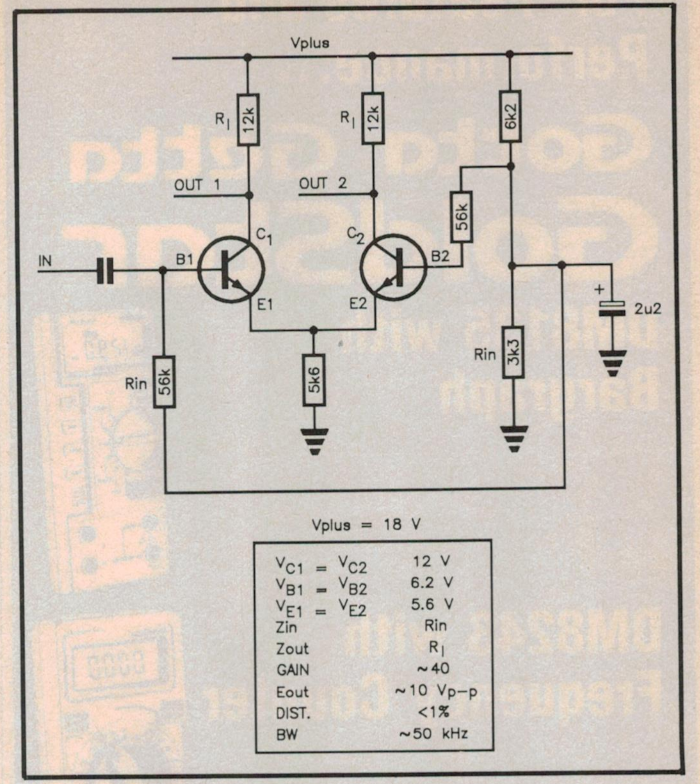

Fig.11.9: Transistor long-tailed pair.

impedances are identical. However, the two output signals are not quite identical in magnitude, but they are sufficiently close for most purposes.

In this circuit the first valve acts in the same way as a single valve phase splitter, but the output from its cathode is coupled to a grounded-grid stage. If the input voltage on the grid of the first triode is increased by 1V, its anode current will increase and so its cathode would tend to rise by, say, 0.9V. Since the grid of the second triode is held at AC earth by the capacitor Cf, the grid has effectively gone 0.9V *negative* with respect to the cathode. This will reduce the cathode current of the second triode, by almost the same as the increase in the current of the first triode.

All of this means that the current in the common cathode resistor remains almost constant, and the voltages on the two anode resistors will go in opposite directions by about the same amount.

If the DC voltages are correct, the circuit should work; a signal injected into the input should produce two equal signals out. If the DC voltages are not correct, check Cf for leakage and then the values of the Rs and Cs.

The transistor version is shown in Fig.11.9. Because of the low cost of transistors, it is common to replace the common cathode resistor of this circuit with a *constant current generator*, as in Fig.11.10. The constant current generator can use either a transistor or a FET. The use of constant current emitter loading has the added advantage that the gain of the first transistor as an emitter follower becomes very close to 1.0, so the AC outputs of the two transistors become almost identical. This circuit has become the preferred phase splitter in a wide range of high fidelity audio amplifiers.

The data in the table accompanying Fig.11.9 are for use of the circuit at audio frequencies; with special transistors using currents of 15mA or more, and using lower DC voltages, this circuit can have a bandwidth of over 100MHz for small signals.

It is rare to find FETs used in this circuit, since their only advantage is high input impedance which is not really needed in the part of the circuit where this phase splitter is used. At very high frequencies the input impedance of a FET is capacitive and is comparatively low, being little different from that of a transistor.

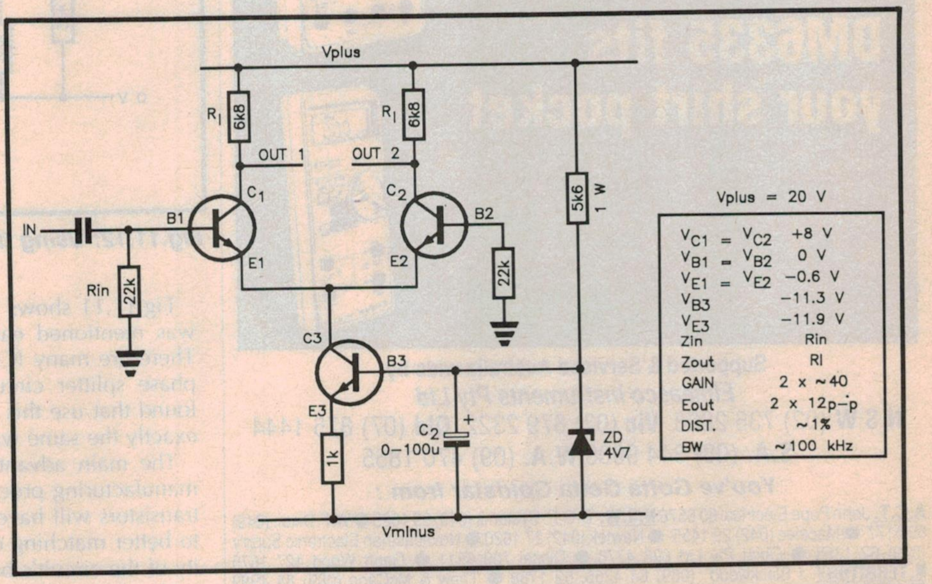

Fig.11.10: Transistor long-tailed pair with constant current source instead of the common emitter resistor.

Note that this is the first circuit block in this series that uses equal positive and negative power supplies. Balanced power supplies makes it easy to maintain Vb1 and Vb2 at DC earth potential. Many designers leave the zener bypass capacitor out to cut costs, but including it gives a small improvement in noise performance.

It is common to DC couple the input of the circuit if the preceding stage has a nominal DC level of zero volts. Simple DC voltage testing will decide whether the circuit should work. Vc1 and Vc2 should both be at about Vplus/2, and Vc3 should be about 0.6V below earth.

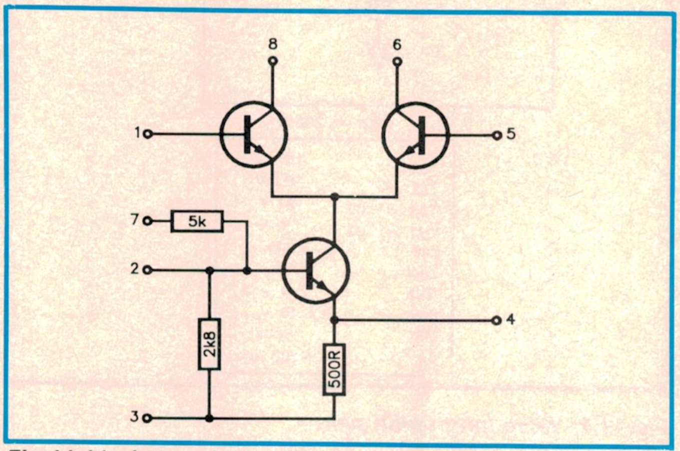

Fig.11.11: Internal circuit of the CA3028A IC. Note the similarity to a transistor phase splitter.

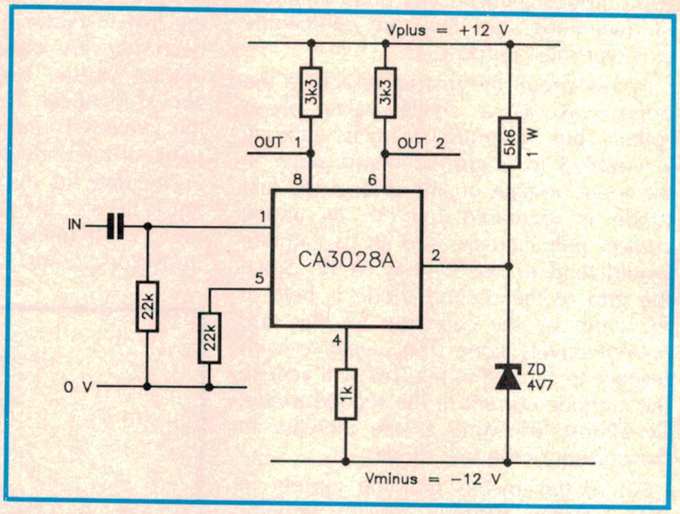

Fig.11.12: Using the CA3028A as a long-tailed pair.

Fig.11.11 shows the internal circuit of the CA3028A, which was mentioned earlier when discussing frequency changers. There are many ICs with similar circuits. The similarity to the phase splitter circuit is obvious, and many circuits will be found that use this type of IC as a phase splitter. It behaves in exactly the same way as described above.

The main advantage of using this kind of chip is that the manufacturing process pretty well guarantees that the two top transistors will have well-matched characteristics, which leads to better matching of the output voltages and improved stability of the circuit's balance with changes in temperature.

The long-tailed pair circuit using this IC is given in Fig.11.12. The three internal resistors are ignored, connections being made directly to the bottom transistor via pins 2 and 4. ●

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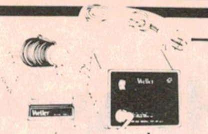

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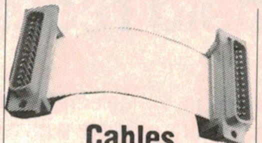

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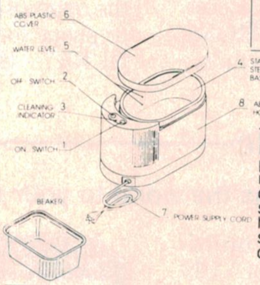

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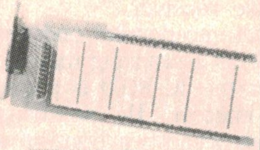

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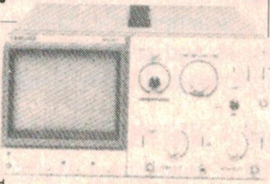

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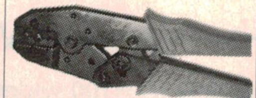

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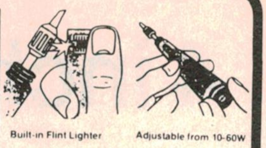

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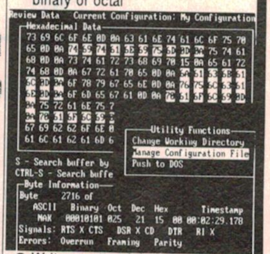

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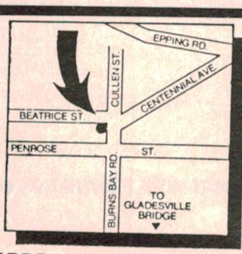

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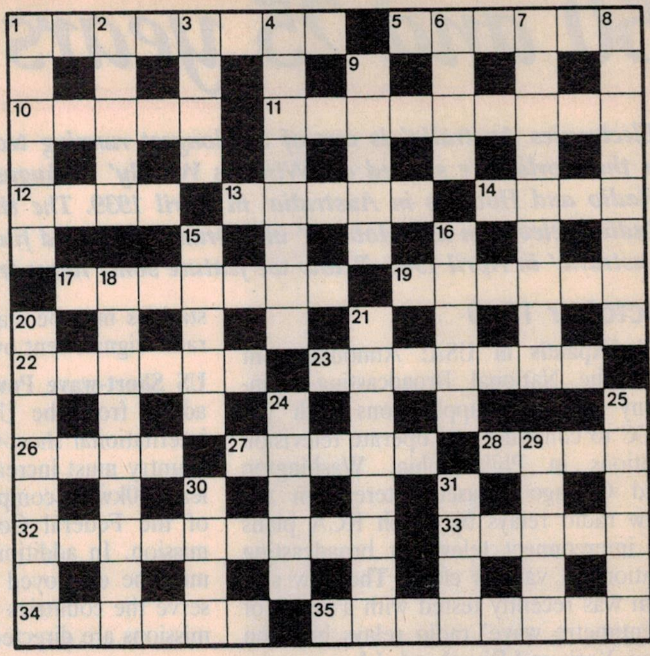

Across

1. Buzz words for advanced design. (4,4)
5. Such waves have very short wavelengths. (6)
10. Loses charge. (5)
11. Said of pagers, multimeters, etc, carried from the waist. (9)
12. Discoverer of many isotopes and winner of Nobel Prize. (4)
13. Track of CRO spot. (5)
14. Bionic ears are made for such people. (4)
17. Inventor of the thermionic diode. (7)
19. Pair of particular charges. (6)
22. Navigational aid, the ---- beacon. (6)
23. Fitted with sound absorber. (7)
26. Transmit a signal. (4)
27. Aiming device, the electronic ----. (5)
28. A Doppler effect, the ---- shift. (4)
32. Carried a current. (9)
33. Region just beyond Earth's atmosphere, ---- space. (5)
34. What German singers have recorded. (6)
35. Record of sounding. (8)

Down

1. A solar gas. (6)
2. A non-SI unit of angle. (5)
3. Conduct a trial of performance. (4)
4. Kind of radiation from a laser. (8)
6. Prefix indicating eight. (4)
7. Signalling system. (5,4)
8. Arranged in a systematic way. (8)
9. Type of circuit diagram. (5)
15. Edit. (5)
16. Type of box for many EA projects. (5)
18. Part of TV signal. (9)
20. Type of change. (8)
21. Concerned with negative electrodes. (8)
24. Local AC frequency in hertz. (5)
25. Electrically erasable memory. (6)
29. Pertaining to the moon. (5)
30. From 17 across we have a ---- for each hand. (4)
31. Acronym for first in, first out. (4)

SOLUTION FOR SEPTEMBER

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'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

October 1940

TV Expands in USA: Announcement that the National Broadcasting Company has filed applications with the FCC to construct and operate television stations in Philadelphia, Washington and Chicago focused interest on the new radio relays by which RCA plans to interconnect television broadcasting stations in various cities. The new system was recently tested with a series of 'centimetre wave' radio relays between New York and Riverhead, LI.

Power to the station, which operates unattended, is supplied from the nearby public service sources; it will automatically switch to its own emergency power supply if line voltage fails and returns – again automatically – when power service is restored. Operation of the relay stations may be started and stopped by radio signals sent over the circuit.

US Short-wave Power Increase: Recent advice from the US states that all the international short-wave stations in that country must increase their power to at least 50kw to comply with a new ruling of the Federal Communications Commission. In addition, directive antennas must be employed so as to adequately serve the countries to which their transmissions are directed.

October 1965

First Atomic Lighthouse: The world's first atomic lighthouse has begun its second year of operation. The beacon, drawing electricity from the radioisotope strontium titanate, began work in May 1964 in the US Coast Guard's Baltimore lighthouse at Chesapeake Bay, Maryland. It is designed to operate unattended for 10 years. The atomic power plant supplants batteries that had to be replaced yearly.

The Coast Guard reported that the performance of the atomic lighthouse 'has been completely reliable and generally excellent.' Similar United States atomic units supplied power to satellites orbited in 1961 and are also furnishing electricity to automatic weather stations in the Arctic, Antarctic, and the Gulf of Mexico; a navigational buoy in the Chesapeake Bay, and a sea-bottom beacon in the Atlantic ocean.

Mile-wide Atom Smasher: Four engineering consultant companies in the US have been selected by the Atomic Energy Commission to begin the study of a gigantic proton accelerator, or atom smasher which will take the form of a ring one mile across.

The beam of accelerated particles to be produced by this machine will have the immense power of 200 Giga electron volts (200,000 million), or eight times as much as the big European machine at Cern in Switzerland and 13 times as much as Britain's Nimrod accelerator.

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16	41	66	91	116	141	166	191	216	241	266	291
17	42	67	92	117	142	167	192	217	242	267	292
18	43	68	93	118	143	168	193	218	243	268	293
19	44	69	94	119	144	169	194	219	244	269	294
20	45	70	95	120	145	170	195	220	245	270	295
21	46	71	96	121	146	171	196	221	246	271	296
22	47	72	97	122	147	172	197	222	247	272	297
23	48	73	98	123	148	173	198	223	248	273	298
24	49	74	99	124	149	174	199	224	249	274	299
25	50	75	100	125	150	175	200	225	250	275	300

OCT '90

Construction project:

New high performance stereo preamplifier - 2

Last month we discussed the performance goals and design of our new *Pro Series Two* preamplifier. In this issue, we present the actual circuit, construction details and troubleshooting hints.

by ROB EVANS

As you can see from the shots of the new preamp, its front panel has quite a spartan appearance and incorporates very few controls. These are the input selector switches, a volume control and a power switch – hardly a knob twiddler's delight. As discussed in the last instalment, this simple approach allows the circuit to deliver its full noise and distortion performance, without the corrupting influence of the usual tone and balance control stages.

All of the preamp's circuitry is contained on one large printed circuit board (PCB), with a small supplementary PCB acting as a connector for the two selector switches. This main board occupies most of the interior space of the standard one-unit rack mount case, while the remaining area holds the toroidal power transformer and its associated mains wiring. All in all, it's a very simple arrangement, which should make the construction process very straightforward.

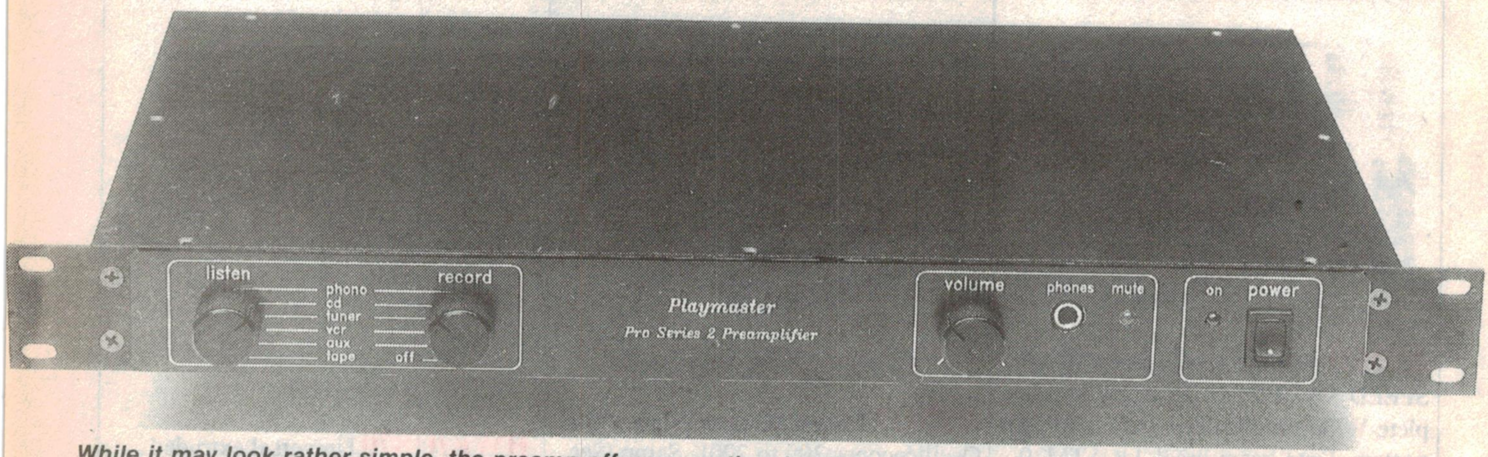
You might also notice that the actual printed circuit board looks quite complex from the copper side, with relatively small areas of unoccupied board. This is mainly because virtually all of the required connections are made by copper tracks on the PCB, rather than with hookup wire and shielded cable. In fact once the PCB is complete, you only need to wire up the input/output sockets and connect the power transformer to have a working preamp...

But an elaborate PCB design doesn't necessarily mean that the circuit itself is unduly complex. In the case of our new preamp, the action of most stages should be quite self-evident.

Circuit description

As shown in the overall circuit diagram, the basis of the preamp's circuitry is the amplifying stage formed around IC2 and IC3, which is a practical version of the low-noise arrangement shown in Fig.1b of last month's instalment. Additional components around this circuit include the coupling capacitors C13, C16, C17 and C20, and compensation capacitors C14, C15, C18 and C19; these define the preamp's final bandwidth at around 10Hz to 100kHz. The two stages are referenced to ground via resistors R17 (IC2) and R21 (IC3), while R16 and R26 terminate the input and output signals respectively.

The output of IC3 is both isolated from capacitive loads and protected from short circuits by R25, which ultimately drives the preamp's main output

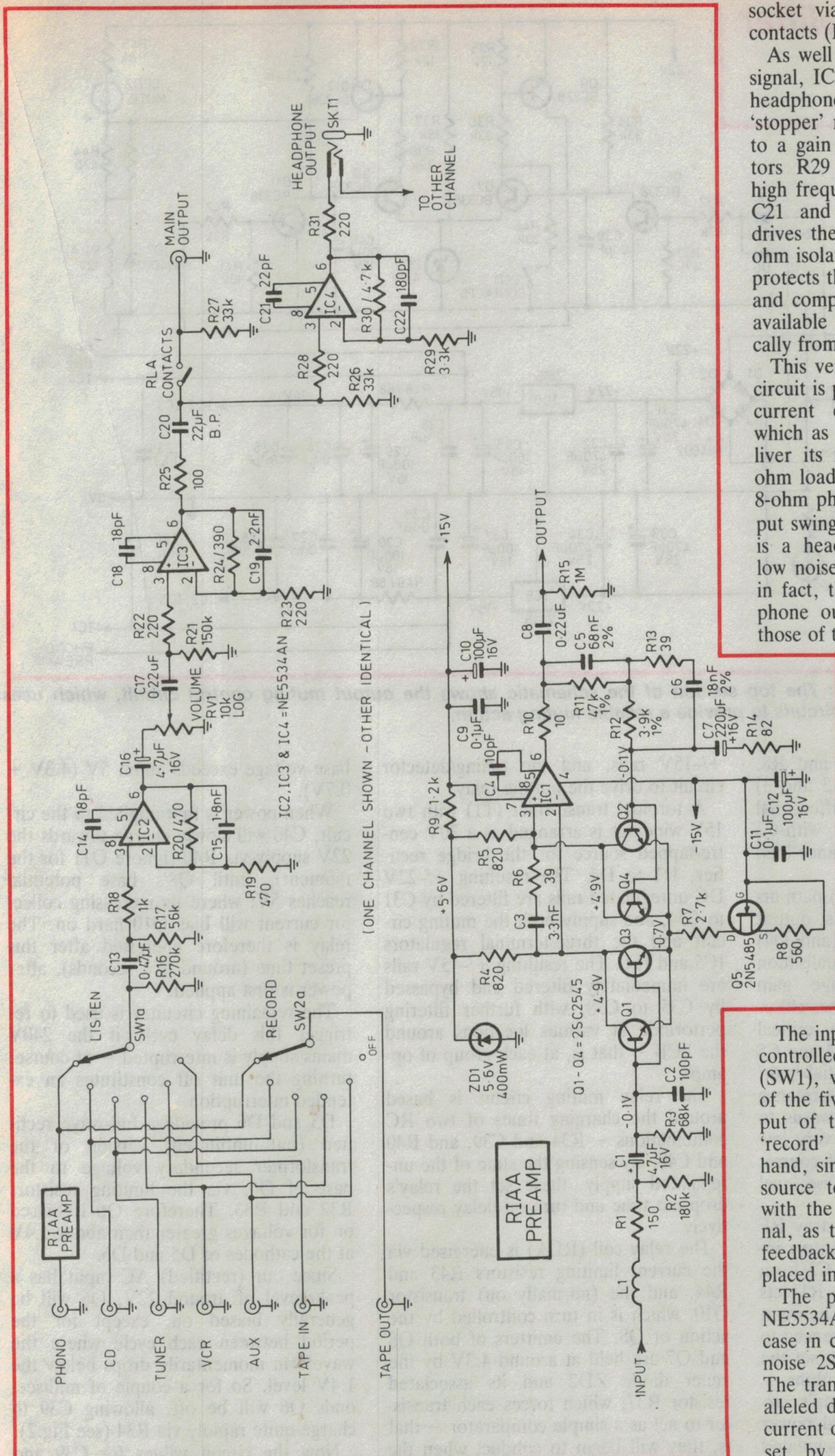


While it may look rather simple, the preamp offers exceptional audio performance.

socket via C20 and the muting relay contacts (RLA).

As well as providing the main output signal, IC3 also supplies signals for the headphone amplifier (IC4), via its input 'stopper' resistor R28. This stage is set to a gain of 2.4 by the feedback resistors R29 and R30, and stabilised by high frequency compensation capacitors C21 and C22. The op-amp's output drives the headphone socket via a 220-ohm isolating resistor (R31), which both protects the output against short circuits and compensates for the wide range of available headphone impedances (typically from 8-ohms to 600-ohms).

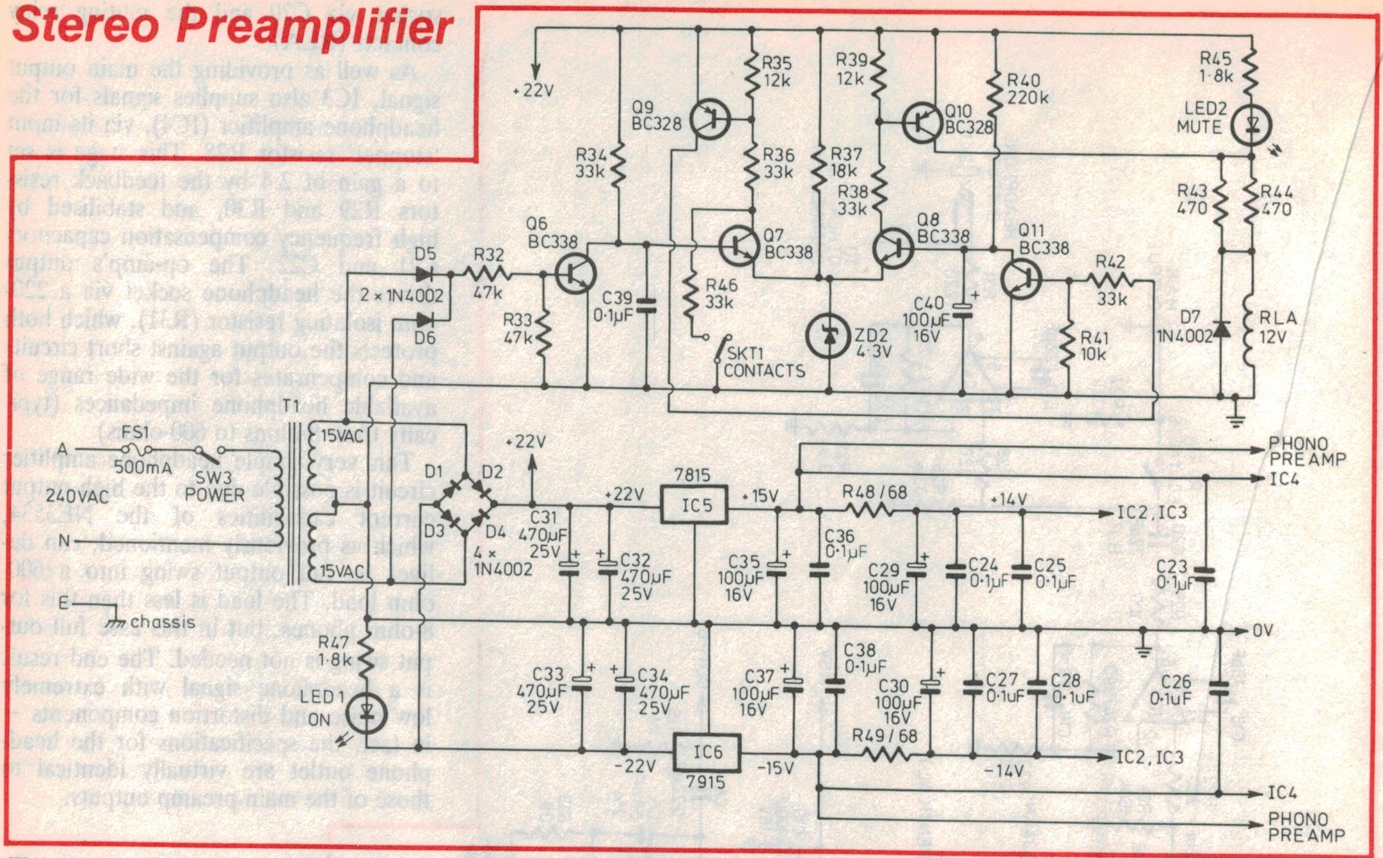
This very simple headphone amplifier circuit is possible due to the high output current capabilities of the NE5534, which as previously mentioned, can deliver its full output swing into a 600-ohm load. The load is less than this for 8-ohm phones, but in this case full output swing is not needed. The end result is a headphone signal with extremely low noise and distortion components – in fact, the specifications for the headphone outlet are virtually identical to those of the main preamp outputs.



The schematics of the signal stages: IC1 and IC2 form a very low-noise gain stage for all settings of the volume control, as discussed in last month's installment. The RIAA (phono) stage uses ultra-low-noise transistors in a paralleled differential pair configuration.

The input to the main preamp stage is controlled by the rotary 'listen' switch (SW1), which selects signals from one of the five high level inputs or the output of the phono preamp stage. The 'record' switch (SW2) on the other hand, simply routes the required signal source to the 'tape out' connector – with the exception of the 'tape in' signal, as this would constitute a positive feedback loop when the tape machine is placed in its recording mode.

The phono stage uses yet another NE5534AN op-amp (IC1), but in this case in conjunction with four ultra-low-noise 2SC2545 transistors (Q1 to Q4). The transistors are configured as a paralleled differential pair, with a standing current of around 1mA for each side, as set by the constant current source



The preamp's power supply: The top section of the schematic shows the output muting control circuit, which uses AC-sensing and two timing circuits to provide a reliable muting action.

formed by Q5 (a FET), R7 and R8. The two op-amp inputs (pins 2 and 3) are driven directly from the differential pair collector loads R4 and R5, with C3 and R6 providing a low impedance load at very high frequencies.

The negative feedback (NFB) path arranged between the op-amp's output (pin 6) and the base of Q2 (and Q4) sets the RIAA phono equalisation curve, and the overall stage gain (around 35dB at 1kHz). This uses close-tolerance components at the critical points, and includes R11 to R14 and C5 to C7. While the input differential 'pair' tends to define the noise performance of this stage, the NE5534 allows us to enhance this figure by using a very low impedance NFB loop – and of course, its own internally generated noise level is extremely low.

To reduce the likelihood of stray RF signals reaching the input circuitry, inductor L1 (around 10uH) and C2 form a suitable low-pass filter, while R1 acts as the usual 'stopper' resistor. The input is AC coupled via C1, and referenced to earth by R2 and R3, which also set the input impedance to around 50k ohms.

The remainder of the preamp's circuitry involves a straightforward power supply, which produces the regulated +/-15V rails, and the timing/detector circuit to drive the muting relay.

A toroidal transformer (T1) with two 15V windings is arranged as a 30V centre-tapped source for the bridge rectifier, D1 to D4. The resulting +/-22V DC unregulated rails are filtered by C31 to C34, and supply both the muting circuit and the three-terminal regulators IC5 and IC6. The resulting +/-15V rails are immediately filtered and bypassed by C35 to C38, with further filtering performed at various locations around the PCB – that is, at each group of op-amps.

The relay muting circuit is based around the charging times of two RC combinations – R34 and C39, and R40 and C40. By sensing the state of the unregulated supply, these set the relay's drop-out time and turn-on delay respectively.

The relay coil (RLA) is energised via the current limiting resistors R43 and R44, and the (normally on) transistor Q10, which is in turn controlled by the action of Q8. The emitters of both Q8 and Q7 are held at around 4.3V by the zener diode ZD2 and its associated resistor R37, which forces each transistor to act as a simple comparator – that is, they will begin to conduct when the base voltage exceeds about 5V (4.3V + 0.7V).

When power is first applied to the circuit, C40 will slowly charge towards the 22V supply via R40 (ignore Q11 for the moment), until Q8's base potential reaches 5V, where its increasing collector current will bias Q10 hard on. The relay is therefore energised after this preset time (around five seconds), after power is first applied.

The remaining circuitry is used to retrigger this delay cycle if the 240V mains supply is interrupted – of course, turning the unit off constitutes an extended interruption.

D5 and D6 provide a full-wave rectified (but unfiltered) version of the transformer secondary voltage to the base of Q6, via the limiting resistors R32 and R33. Therefore Q6 is biased on for voltages greater than about 1.4V at the cathodes of D5 and D6.

Since our (rectified) AC input has a peak level of around 22V, Q6 will be generally biased on, except for the period between each cycle where the waveform momentarily drops below the 1.4V level. So for a couple of milliseconds Q6 will be off, allowing C39 to charge quite rapidly via R34 (see Fig.2).

Now the circuit values for C39 and

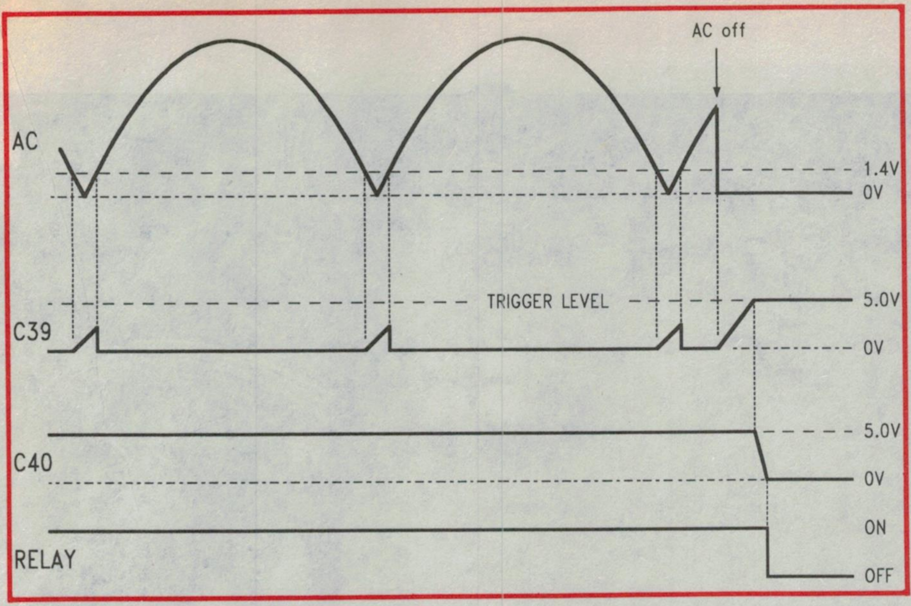


Fig.2: The operation of the AC-sensing section of the muting circuit. If the (rectified) AC input drops to 0V for more than a few milliseconds, the relay is de-energised.

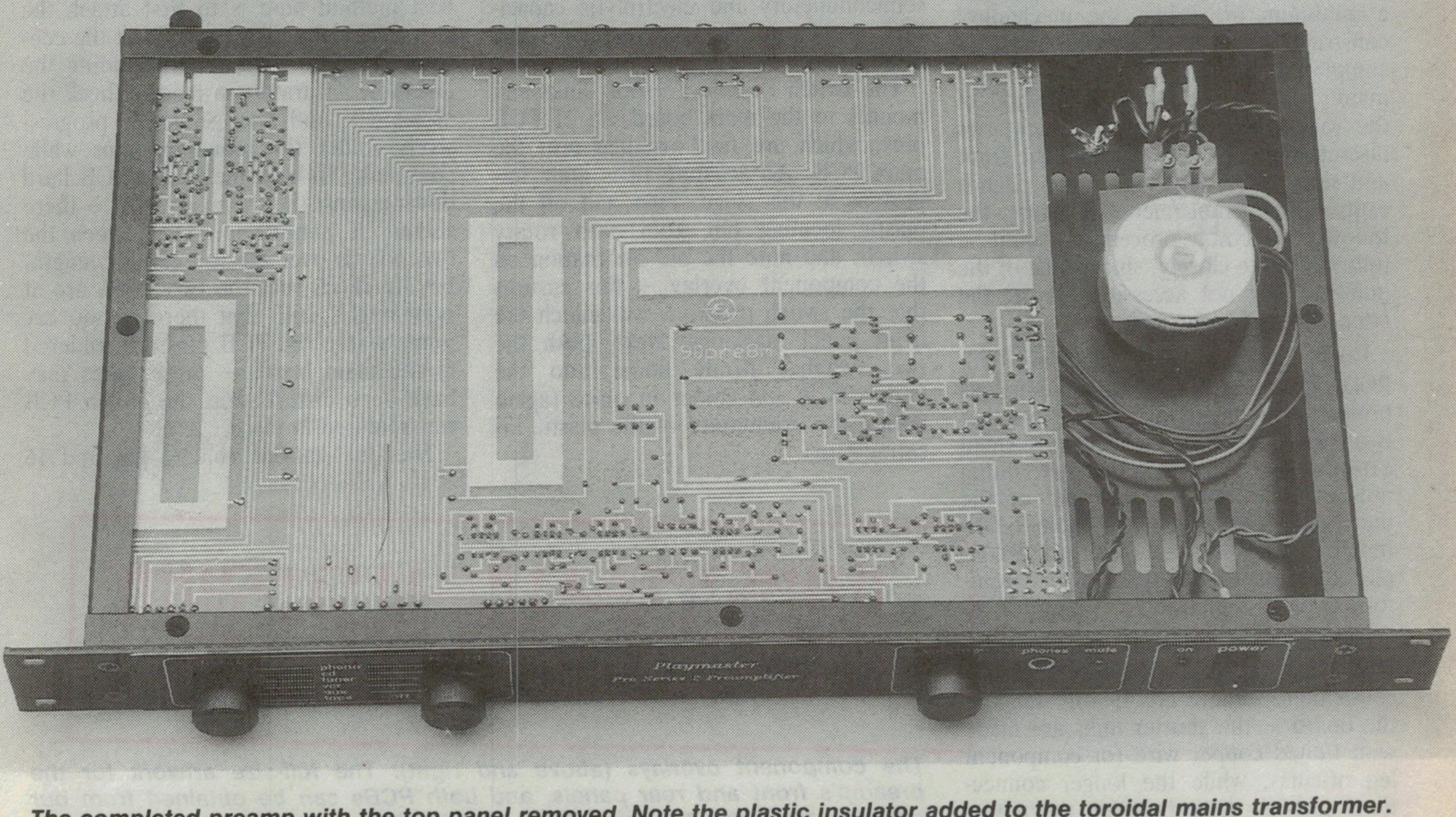
R34 have been chosen so that the capacitor will charge to a maximum level of around 2 volts, before it is discharged by Q6 at the end of the period. In fact the RC combination has a time constant of around 3ms. This means that in the normal course of events (a continuous AC supply), the voltage across the capacitor will not reach the trigger level at the base of Q7 – that is, the 5 volt level mentioned above.

On the other hand, if the AC supply is interrupted for more than about 4ms, C39 has enough time to charge to the trigger level of Q7, allowing it to conduct. This in turn forces Q9 and Q11 into their saturated states, via R36 and R42 respectively. The action of Q11 will quickly discharge the main timing capacitor, dropping the base of Q8 to 0V and ultimately de-energising the muting relay.

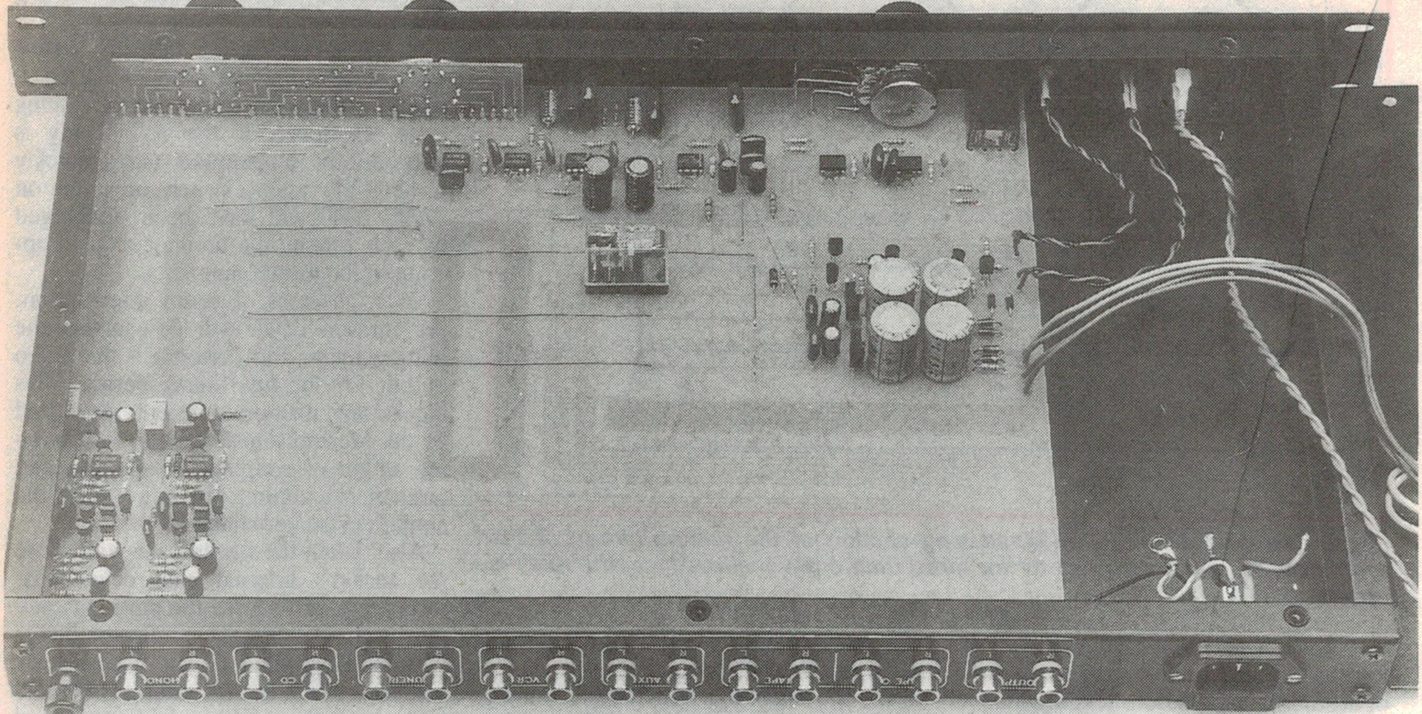
As the supply voltage falls, the circuit will not have enough power to re-energise the relay or complete the timing cycle. However, if the AC supply is only briefly interrupted (say, quickly turning the mains switch off then on again), C40 will have been discharged by Q11, forcing the timing circuit to operate in its normal manner.

So in all cases of mains interruption, the turn-on delay will de-energise the muting relay, and disconnect the audio output for the *full* timing period. This blocks any turn-on transients produced by the preamp (mostly due to the charging action of coupling capacitors), and ensures maximum protection for the amplifier/speaker chain.

Also, when the headphones are in use the socket's internal changeover contacts are used to force the muting circuit into its reset state. The collector of Q7 is pulled low via R16 and the socket's contacts, which in turn saturates Q9 and Q11. As before, C40 is discharged, and the relay is de-energised via Q8 and Q10. In this case however, the circuit will remain in this condition (with the output muted) until the headphones are disconnected.



The completed preamp with the top panel removed. Note the plastic insulator added to the toroidal mains transformer.



The component side of the PCB faces the unit's bottom panel. As you can see, it's quite a spacious layout.

Construction

While we've taken some pains to ensure that building the Pro Series Two preamp is a straightforward process with a minimum of wiring, the mechanical construction can be a little tricky if not completed in the right order. This is mainly due to the assembly method of the rack-mount case itself, which uses discrete nuts and bolts to hold the front and side panels together, rather than a captive nut arrangement. In short, the following assembly procedure should be followed quite closely, since some of the nuts are just not accessible during the later stages of construction.

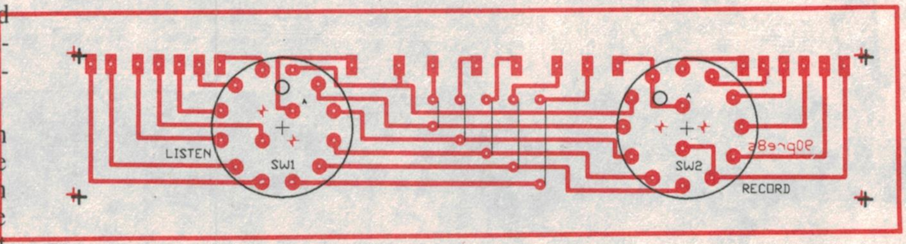
Begin by thoroughly checking both PCBs for any etching anomalies, such as bridged or open circuit tracks. Note that two corners of the main PCB have small cut-outs to clear the panel-mounting nuts at the 'listen' switch end of the unit. Also check that the main board fits neatly into the case, with just a couple of millimetres to spare in the front-to-rear panel dimension.

Mount the components on the main PCB, starting with the lowest profile components. There are 19 wire links in the board – the shorter links are made with tinned copper wire (or component leg offcuts), while the longer connections such as those between the power supply and phono stage should be formed with insulated wire. As usual, take particular care with the orientation of polarised components, such as the semiconductors and electrolytic capacitors – refer to the component overlay at all times.

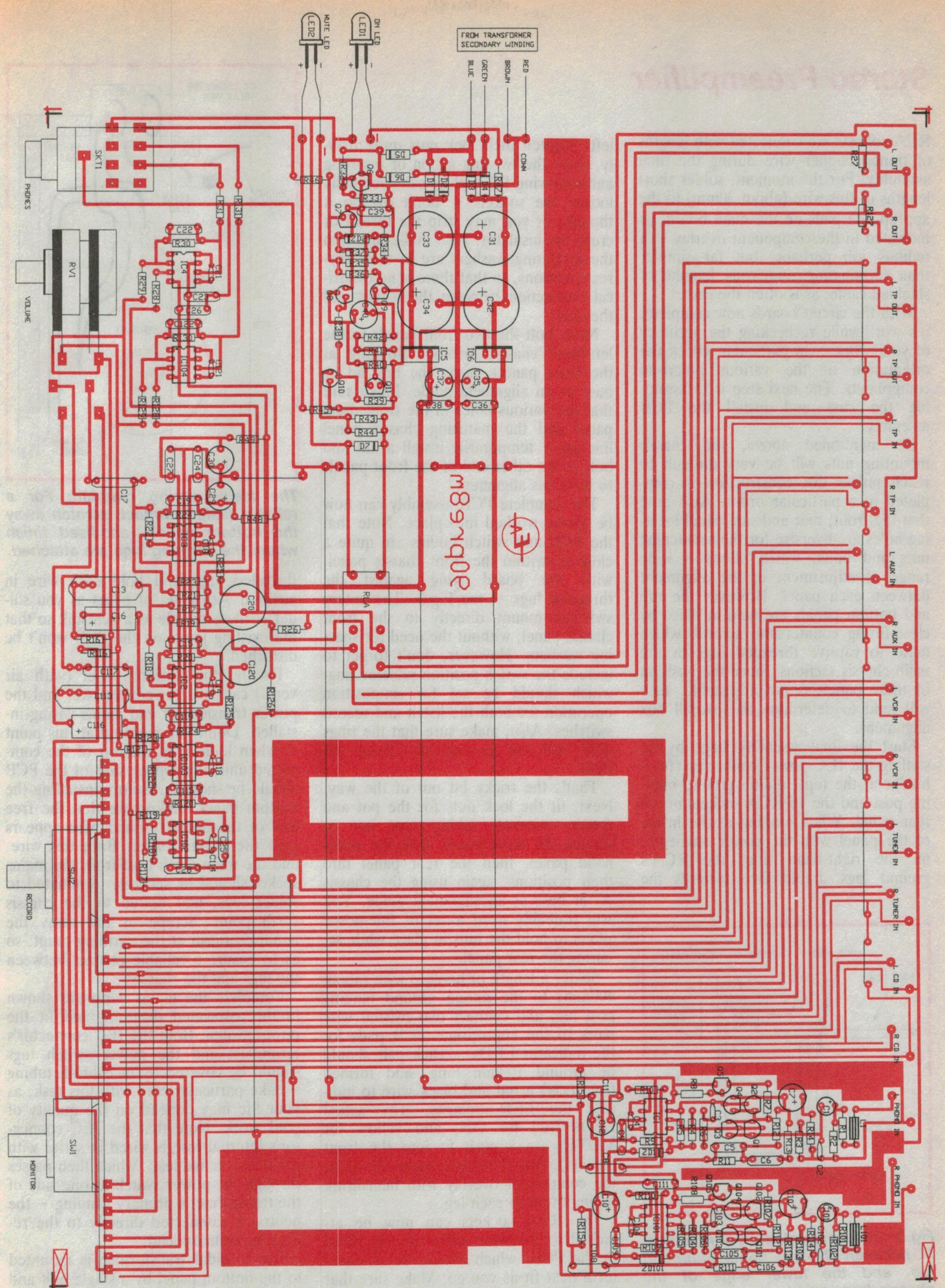
The switch PCB has 5 short links and mounts to the main board via 21 PCB pins, which are first installed into the main PCB. An accurate fit is quite important at this stage. First, cut off the plastic locating pin from each rotary switch, and note the pin orientation on the component overlay – this ensures that the switch positions will match the front panel markings. Next, push the two switches firmly home into the switch PCB and solder in place (again noting the orientation of the plastic locating pins).

To avoid difficulties during final assembly steps, the edge of the completed switch PCB must be mounted flush to the main PCB, over its *full* length. The best method here is to first attach the switch PCB by only a couple of the centre PCB-pins, while firmly holding the assembly accurately in place. Check the alignment, and once satisfied, progressively solder the remaining pins while continuing to hold the switch PCB hard down against the the main PCB – there should be almost no gap between the two boards over the full contact length. Finally check that the two PCBs are at right angles, and that there are no dry joints where the PCB pins are soldered to the main board – these joints may have been disturbed as the switch PCB was soldered in place.

The dual-ganged volume pot and 16



The component overlays (above and right): The full-size artwork for the preamp's front and rear panels, and both PCBs can be obtained from our office by sending a $10 service fee – it's too large to publish in actual size.


MUTE LED
LED2
ON LED
LED1
FROM TRANSFORMER
SECONDARY WINDING
BLUE
GREEN
BROWN
RED

RCA sockets are connected with lengths of tinned copper wire during the final assembly. For the moment, solder short lengths of this wire (about 30mm) to the appropriate pads on the main board, as indicated in the component overlay – a tedious job perhaps, but far simpler than terminating numerous lengths of shielded cable, as is often the case.

With the circuit boards now complete, it's worthwhile rechecking the accuracy of your work – in particular, check the orientation of the various polarised components. The next step is to assemble the case and install the PCB assembly.

As mentioned above, the chassis mounting nuts will be very difficult to reach unless this construction is completed in a particular order. Also note that the front, rear and side panel locating holes are oversize for their matching nuts and bolts, which allows a wide range of adjustment in the alignment between each panel. However the top and bottom panels are held in place by close-fitting countersunk screws, which mate to captive threaded lugs in the main chassis sections. Since the position of these panels is not adjustable, they will tend to determine the overall box alignment.

Start the final assembly stage by installing the IEC power connector (fuseholder at the top), phono ground binding post and the 16 RCA sockets in the rear panel. When looking at the inside of the panel with the power connector on the right-hand side, the RCA's ground tags should face towards the left. Tighten their lock nuts quite firmly, since the twisting action of inserting and removing RCA plugs can eventually loosen the sockets – don't overdo it though, or you may strip the thread or crush the insulator. Also make sure that the insulating washers are in their correct positions, so that there is no electrical connection between the socket and the case.

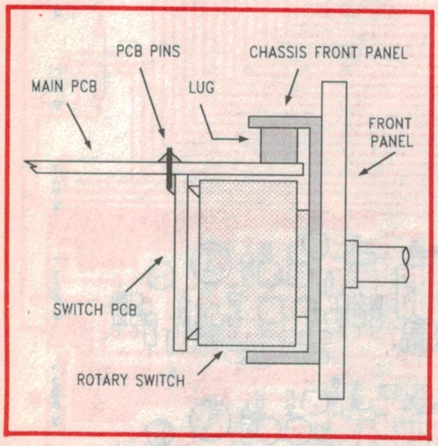


Fig.3: The completed PCB is a neat fit between the top panel mounting lug, and the lower edge of the chassis front panel.

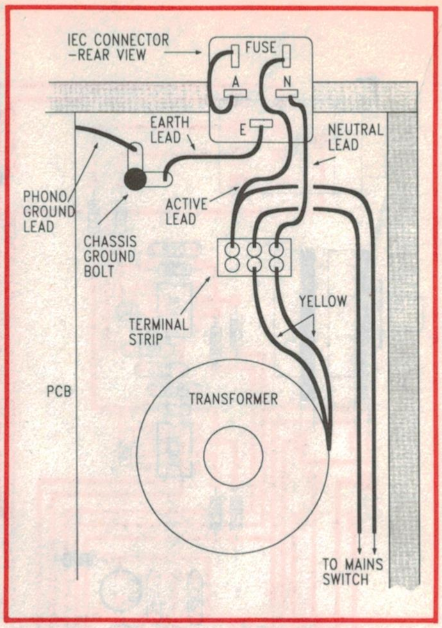
Next, bolt the two front panels to the left-hand chassis member (looking at the front panel), using the box lid or base as an alignment guide. Make sure that the various holes in the front dress panel and the matching chassis panel line up – temporarily install a nut and bolt in the other end of the front panels to hold this alignment.

The complete PCB assembly can now be gently worked into place. Note that the PCB and switch bodies are quite a close fit within the front chassis panel, with the board lying against the threaded lugs – see Fig.3. The rotary switches mount directly to the front chassis panel, without the need for spacing washers. However, don't forget to include the switch position selector ring, which should be set for six-position operation for both the listen and record switches. Also, make sure that the rings don't fall out as you are fitting the PCB.

That's the tricky bit out of the way. Next, fit the lock nuts for the pot and rotary switches, taking care not to scratch the front panel. Bolt the right-hand panel, then the rear panel into their positions, again using the chassis lid or base as an alignment guide. You will probably need a set of fine-nosed pliers to hold the nuts in place while securing the rear panel.

Solder a length of hookup wire (about 400mm) to the phono ground binding post lug, and connect two twisted wire pairs to the appropriate PCB pads for the indicator LEDs – each pair should be around 100mm long, and formed from (say) a red and black wire to indicate the LED polarity. The actual LEDs (red for ON, and yellow for MUTE) are a push fit into the front panel(s), and are connected as shown in the component overlay with heatshrink tubing fitted to each leg.

The RCA sockets can now be attached to the wire stalks already fitted to the PCB, which should be trimmed for a neat fit as you go. Make sure that the PCB is sitting on the rear panel's threaded lugs, and hold each wire in position with a set of pliers as you solder – these double as a heatsink so that the existing joints on the PCB won't be disturbed.

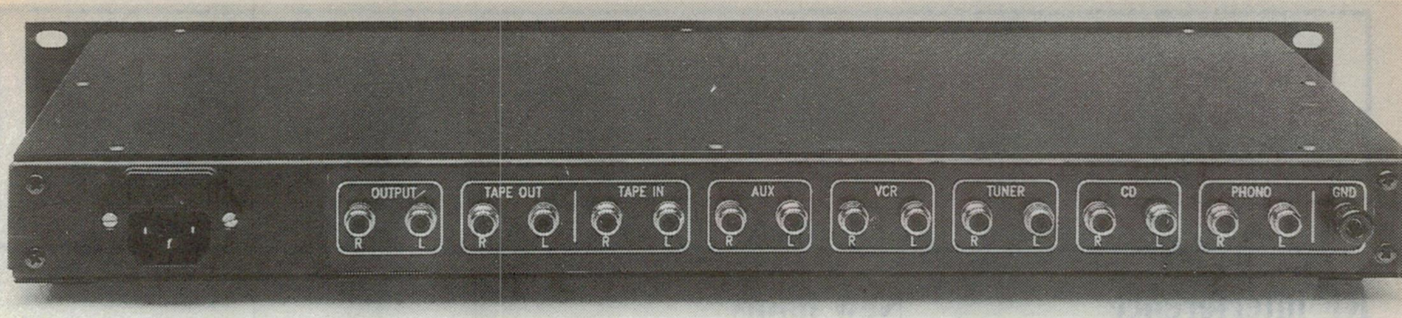


The mains wiring diagram: For a reliable (safe!) contact, scratch away the bottom panel's anodised finish where the earthing lugs are attached.

Finally, the bottom panel (with air vents) can be screwed in place, and the power transformer and mains wiring installed. Don't get confused at this point – when looking at the *top* of the completed unit, the *copper side* of the PCB should be showing. Before installing the bottom panel, make sure that the free end of the phono ground wire appears near the power socket. Both this wire, and the main earth lead from the mains socket should be securely terminated to solder lugs, and bolted to the chassis earth point. Scrape or file away the anodised finish at the earthing point, so as to ensure a reliable contact between the lugs and the chassis.

Complete the mains wiring as shown in the associated diagram, and fit the power switch. Both the IEC connector's terminals, and the power switch lugs should be covered by heatshrink tubing – take particular care with this task, as your life may depend on the quality of your work. Note that the IEC connector's internal fuse is wired in series with the mains active lead, which then passes through the power switch to one side of the transformer's primary winding – the neutral is connected directly to the remaining primary lead.

The toroidal transformer is mounted to the bottom panel by a single bolt and top plate, and cushioned by two neo-



The insulated RCA sockets that we used were a tight fit for most RCA plugs. Before using the preamp, you may need to flare the tip retaining part of each socket with a tapered tool.

prene rubber washers. The bolt only requires a moderate tension to hold the transformer firmly in place and shouldn't be overtightened, as this could stress the unit's internal insulation.

You may notice that we have attached a square of plastic to the top of the transformer. This serves to insulate the transformer's mounting plate and bolt from the top panel, and should be included. The reasoning follows that if the panel was forced into contact with these metal parts, a shorted turn would be formed by the chassis and the bolt, resulting in a heavy circulating current and transformer overload. If we assume that the top panel could be deformed, it may be worthwhile placing a piece of cardboard on top of the PCB, before it is finally installed. Nevertheless, the preamp's top panel is *not* the ideal place for a pot plant.

Final checks

In its completed form, the easiest way to ensure that the preamp is functioning correctly is to turn it on, and plug in a set of headphones. However, for the more cautious constructors, a few voltage checks may be prudent.

The first thing to check in this case is the power supply voltages, where the regulator output pins should read close to +15V and –15V. Although you will only have direct access to the copper side of the PCB, it's not too difficult to find the appropriate points by interpreting the component overlay. For a complete check, monitor the voltage at the output of each 5534 op-amp (pin 6) – it should be quite close to 0V.

When the unit is powered up, the ON and MUTE LEDs should immediately illuminate, with the MUTE turning off some 5 or so seconds later. This time period is not critical, so don't be too concerned if yours is a little different due to component tolerances – of course, a gross error would indicate that

Continued on page 112

PARTS LIST

1 1-unit rack-mounting case, black
1 PCB code 90pre8m (main board), 244 x 328mm
1 PCB code 90pre8s (switch board), 27 x 148mm
1 15VA toroidal transformer, 30V centre-tapped, with mounting hardware
1 mains rated SPST miniature rocker switch
1 IEC male chassis socket, with built-in fuse holder
1 IEC-terminated mains power lead
1 M205 500mA slow-blow fuse
2 2-pole 6-position sealed PCB-mount rotary switches
3 22mm diameter black anodised knobs
1 6.5mm PCB-mount stereo socket, with internal DPDT switch
1 PCB-mount DPDT relay, 12V 300 ohm coil
2 FX1115 (or equivalent) ferrite beads
16 panel-mount insulated RCA sockets
1 black binding post
2 solder lugs
1 3-way mains rated terminal strip

Resistors

All 1/4W, 5% unless noted: 2 x 10 ohms, 4 x 39 ohms, 2 x 68 ohms, 2 x 82 ohms, 2 x 100 ohms, 2 x 150 ohms, 8 x 220 ohms, 2 x 390 ohms, 4 x 470 ohms, 2 x 470 (0.5W), 2 x 560 ohms, 4 x 820 ohms, 2 x 1k, 2 x 1.2k, 2 x 1.8k (0.5W), 2 x 2.7k, 2 x 3.3k, 2 x 3.9k (1%), 2 x 4.7k, 1 x 10k, 2 x 12k, 1 x 18k, 9 x 33k, 2 x 47k, 2 x 47k (1%), 2 x 56k, 2 x 68k, 2 x 150k, 2 x 180k, 1 x 220k, 2 x 270k, 2 x 1M, 1 x dual-gang 10k log potentiometer

Capacitors

2 10pF ceramic
4 18pF ceramic
2 22pF ceramic
2 100pF ceramic
2 180pF ceramic
2 1.8nF metallised polyester
2 2.2nF metallised polyester
2 3.3nF metallised polyester
2 18nF (2%) metallised polyester
2 68nF (2%) metallised polyester
13 0.1uF metallised polyester
4 0.22uF metallised polyester
2 0.47uF metallised polyester
2 4.7uf 16VW axial electrolytics
2 22uF bipolar PC-mount electrolytics
2 47uF 16VW PC-mount electrolytics
7 100uF 16VW PC-mount electrolytics
2 220uF 16VW PC-mount electrolytics
4 470uF 25V PC-mount electrolytics

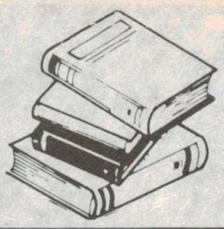
Semiconductors

8 NE5534AN op-amps
1 7815 3-terminal regulator
1 7915 3-terminal regulator
8 2SC2545 low noise NPN transistors
4 BC338 NPN transistors
2 BC328 PNP transistors
2 2N5485 FETs
7 1N4002 diodes
2 5.6V 400mW zener diodes
1 4.3V 400mW zener diode
1 5mm red LED
1 5mm yellow LED

Miscellaneous

Nuts and bolts to suit terminal strip and solder lugs; tinned copper wire; red and black hookup wire; enamelled copper wire (0.3mm or 28 B&S); 21 x PCB pins; heatshrink tubing
3V 400mW zener diode
1 5mm red LED
1 5mm yellow LED

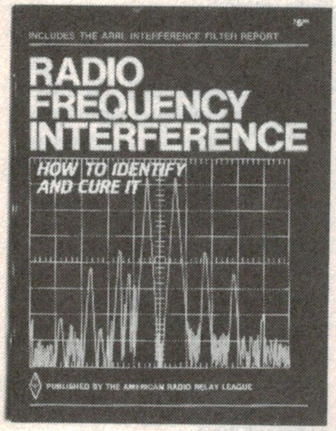
NEW BOOKS AND LITERATURE



RF interference

RADIO FREQUENCY INTERFERENCE, edited by Charles L. Hutchinson K8CH. Fifth edition, 1989, published by The American Radio Relay League. Soft covers, 277 x 210mm, 72 pages. ISBN 0-87259-042-9. Recommended retail price $12.50.

Radio frequency interference or 'RFI' has been a problem ever since radio communications and electronics began,



back at the beginning of this century. As radio technology itself has become more sophisticated, the sources of potential interference have also multiplied – including those from other kinds of radio communication. So it's a problem that is likely to remain with us indefinitely, one way and another.

Radio amateurs are often involved in RFI problem solving, either as inadvertent perpetrators or as victims themselves – 'interferors' or 'interferees', as the Yanks would put it. They can also become involved either by accident, being wrongly blamed for RFI caused by CB operators or a nearby welder, or simply by being called in as an advisor/problem solver.

This is the fifth and updated edition of the ARRL's little manual dedicated to providing information on RFI problem solving. Like the previous editions it takes a practical and positive approach: that RFI problems can be solved, by investigating them in a logical manner and then applying the right techniques.

Needless to say it covers the basic principles of RFI generation, propagation and infiltration into both receivers and other equipment. It also covers the techniques needed to both prevent its generation, and minimise its influence. And all in a very down-to-earth, practical way.

Of course the emphasis is basically on the US scene, as you'd expect. But the techniques and RFI filtering gear described would also be equally suitable here, in most cases.

In short, a handy and up to date little reference on solving widespread but little-understood problems.

The review copy came from Stewart Electronic Components, of PO Box 281, Oakleigh 3166, which can supply the book by mail for the price given. The firm can also be contacted on (03) 543 3733.

New hams

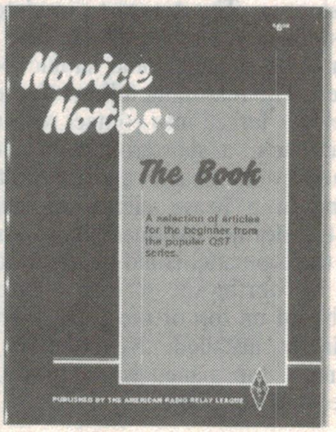
NOVICE NOTES: THE BOOK. Published by the American Radio Relay League, 1989. Soft covers, 279 x 210mm, 80 pages. ISBN 0-87259-256-1. Price $12, post free.

For some time now the ARRL's magazine *QST* has been running a regular series of articles under the running title 'Novice Notes'. Sometimes they're tuitional material; sometimes they're first-hand accounts of the experiences of newcomers to the world of amateur radio – how they first became interested, the thrill of making their first contact on the air, and so on. The continuing emphasis is always on building the skills and fostering the enthusiasm of new hams, so that they gain the confidence to remain in the hobby.

As the title suggests, this book is a collection of some 22 articles from the series. There are 15 articles dealing with aspects of operating, and a further seven dealing with technical aspects of equipment and antennas.

Topics covered include code operating procedures, the ?Q' code, phone operation, the phonetic alphabet, packet radio basics, keeping a station log, QSL cards, contests, chasing awards, licence upgrading, using second-hand gear, receiver filters, antenna tuners and inside antennas. Plus, of course, articles and boxes along the lines 'how I got going' and 'what a thrill it was when I made my first contact'.

It's all good, down to earth stuff, and just right for the person starting out in amateur radio. The emphasis is naturally on the US ham radio scene, but apart from the specific bands and modes available to the US 'Novice' and 'Technician' licences, compared with our own 'Novice' and 'Limited' calls, just about everything else is equally appropriate here.



The text is clearly written, and includes a lot of useful reference material – even though some does get repeated a few times (such as the phonetic alphabet). So all in all, it's a very handy little volume...

The review copy came from Stewart Electronic Components, of 44 Stafford Street, Huntingdale 3166 (PO Box 281, Oakleigh), which can supply copies by mail at the above price. (J.R.)

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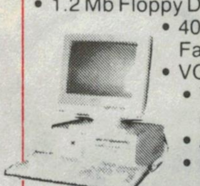

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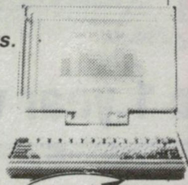

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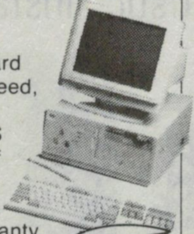

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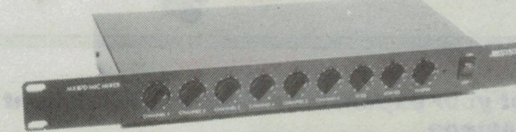

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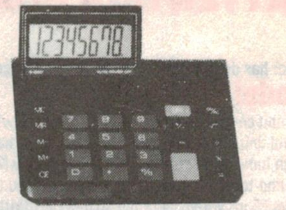

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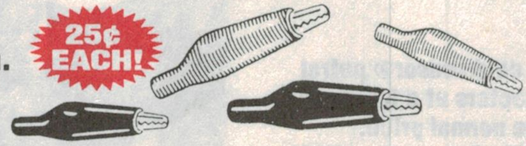

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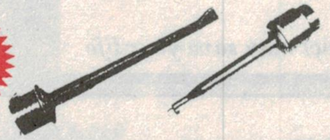

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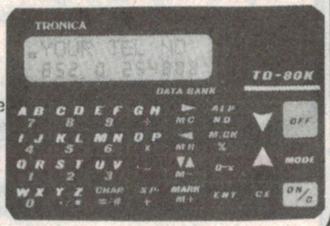

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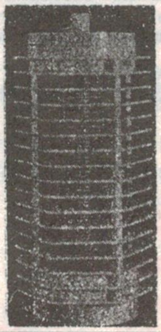

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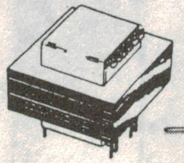

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THE ULTIMATE HI-FI PREAMP

At last! A totally new design preamp to match up to the spectacularly successful Pro-Series I power amp! This exceptional performer is, as you would imagine, housed in a 1 x rack unit cabinet. The Jaycar kit features a fully punched professionally Australian made cabinet. Absolutely no holes to drill or punch! Be wary of other kits which may only include an unpunched HK made box.

FEATURES: The main feature of this unit is its performance capability. In line with state-of-the-art design philosophy extraneous control have been eliminated from the signal path. The design totally avoids the use of screened hook up wire. It is consequently very easy to build. Signal-to-noise performance is staggering - up to 115dB! This machine is basically a wire with gain! Max distortion is 0.002%.

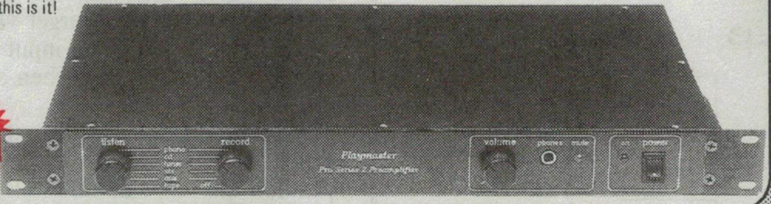
Inputs for phono, line, CD, etc, abound with the ability to record from source to tape and monitor another source at the same time. In keeping with the serious nature of the equipment, the only front panel control is for volume. If you think that you need 'tone' controls forget this product. It is for serious audiophiles only.

Jaycar collaborated with EA on both the Pro-Series I power amp and this exciting new preamp. Because of this, we are uniquely qualified to provide you with the best possible kit! As usual, nothing is spared to compromise quality. So if you want the best, this is it!

Cat. KA-1730

$329

NEW KIT



Pro Series Power Amp Kit

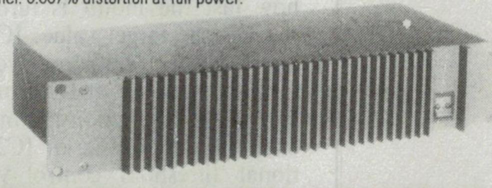
Ref: EA December 1988

140W rms per channel. 0.007% distortion at full power.

Full kit

Cat. KA-1725

$599



STUDIO 200 HI FI PREAMP

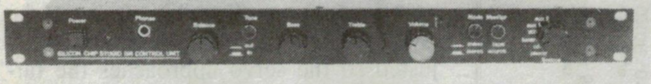
Ref: Silicon Chip June, July 1988

High quality, reasonably priced Hi Fi stereo preamp is presented here. Ideal for home or road work it can be matched with any power amp with a standard input sensitivity of 1V rms. It is housed in a 44mm black rack case and requires 240 volts AC.

See catalogue for full details.

Cat. KC-5033

$229



Remote Control Extender for VCR's

Ref: Silicon Chip September 1990

There's no need to buy a second VCR for the bedroom. This simple kit will allow you to operate your VCR using its remote control from any room in the house.

Kit includes all standard components, PC board and box.

Cat. KC-5084

$29.95

NEW KIT

Disco Light

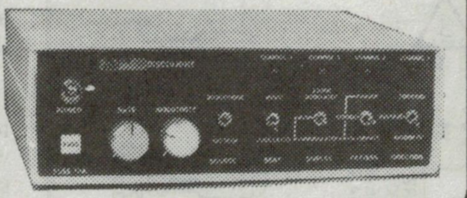
$159.50

Ref: Silicon Chip July 1988

Now you can have all the exciting light show effects of disco's in your home.

The Discolight will drive 4 separate channel of light - 500 watts per channel. It can be driven directly away form a speaker or by the build-in microphone. It can also produce all sorts of light patterns on its own including chasing - so, between songs it does its own thing to entertain.

Cat. KC-5032



RF Voltmeter Probe to Suit UHF Powermatch. MK2

Refer: EA September 1990

Kit includes PC board and all components; except 1 x 80mm length 16mm brass tube

Cat. KA-1729

$7.50

NEW KIT

Low Cost 3-Digit Counter Module

NEW KIT

Ref: Silicon Chip September 1990

Looking for a cheap module for event counting or to be used as part of a larger project? If so, consider this 3-digit counter module. It uses only two low cost CMOS IC's and can be put together in a couple of hours. Buy 2 kits and gang them together and get 6 digits and so on!!

Short form kit includes PC board and compo nents.

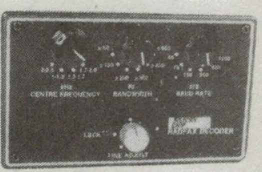
Cat. KC-5083 **$23.95**

RADFAX DECODER

Ref: Silicon Chip November 1989

Cat. KC-5059

$44.95



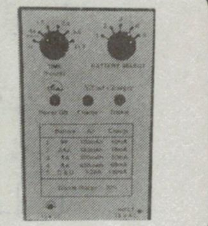
AUTOMATIC NiCad CHARGER

Ref: EA July 1989

Kit includes PCB, box, front panel and all components.

Cat. KA-1718

$42.50



Ni Cad DISCHARGER

Ref: EA September 1989

Kit includes PCB, box, front panel and all specified components. It is powered by the charger above.

Cat. KA-1719

$27.95

Jaycar ELECTRONICS

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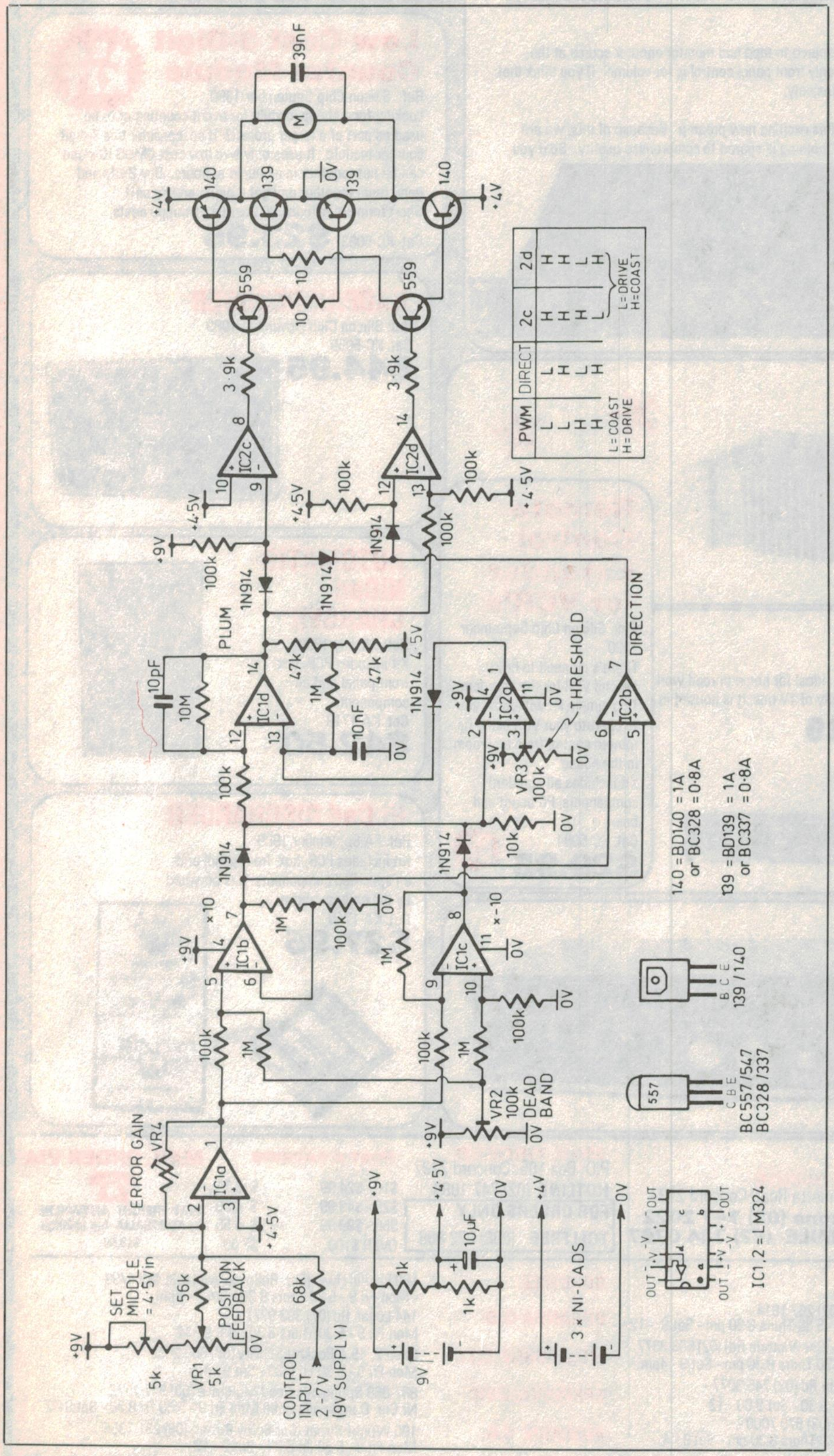
SPRINGVALE VIC	887-889 Springvale Road Mulgrave (03) 547 1022 Nr Cnr. Dandenong Road Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 2
ADELAIDE S.A.	190 Wright Street (Cnr Selby Street) (08) 231 7355 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 12

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.



Servo system for robotics

This circuit was developed to enable a small 3V motor and gear train to be used as a servo mechanism. It provides excellent control, with the drive to the motor being decreased as the mechanism approaches the target value. The target value is set by an input DC voltage between 2 and 7V, when a 9V supply is used.

IC1a produces a voltage that is the error between the target value and the position the servo motor is at (fed back via VR1). This value is multiplied by 10 and –10 by IC1b and 1c respectively. In addition 'dead band' pot VR2 controls how fast the motor is turning when it reaches the target value. IC1d is a voltage-to-pulse width converter which takes the greater of IC1b or IC1c. IC2b controls the direction the motor rotates, enabling either IC2c or IC2d. An additional 'threshold' control VR3, fed via IC2a, cuts out the drive to the motor as it gets very close to the target value.

To set the pots, set the 'error gain' pot VR4 to about midrange, then threshold pot VR3 to 0V, and adjust the dead band pot VR2 so the motor is just hunting about the target value. The threshold pot should be adjusted so the motor stops moving when it is at the target value. The error gain pot is adjusted so the servo approaches the target position as rapidly as possible, without overshooting. The threshold feature allows much more rapid approaches than would normally be possible.

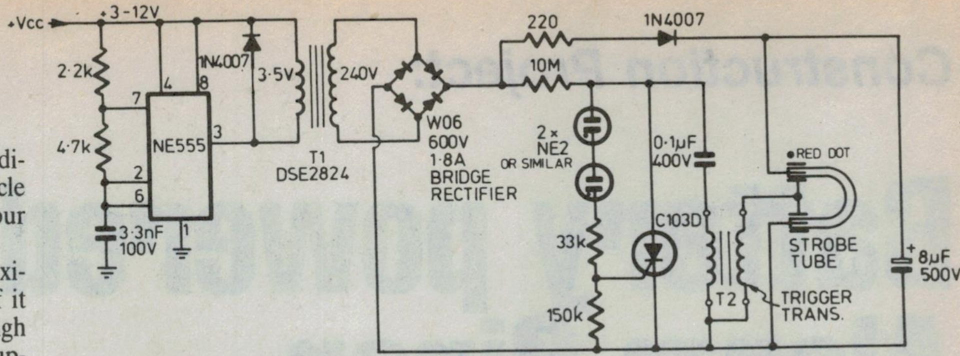
The cheapest method to implement this is to buy a small battery operated toy car. If you hunt long enough you will find the type that has a separate steering control to the motor control. Alternatively the steering mechanism from a radio control car can be salvaged. The connections to the feedback pot can be made using pieces of wire and plastic glued together with superglue or Araldite.

James Moxham,
Urrbrae. SA.

$50

If you have developed an interesting circuit or design idea, and you'd like to tell others about it, draw out your circuit, jot down some notes and put the lot in the mail to us here. We pay for those we publish – not a fortune, but enough to reward your efforts. (See page 3 for address details)

Battery operated strobe 'beacon'



This circuit is for a beacon for additional visibility when riding a bicycle (i.e., to alert motorists of your presence).

The circuit happily runs from approximately 3volts up to about 12 volts. If it is operated at higher voltages, the high voltage components may need to be uprated somewhat. I am using rechargeable AA cells to operate the circuit from 9 volts, and it runs for many hours.

A faster flash rate may be attained by lowering the value of the 10M resistor, with a consequent shortening of battery life. With the addition of solar cells and a light dependent switch, the circuit could be made to work as a nocturnal beacon somewhere.

The circuit consists of two parts: the voltage inverter and the strobe unit. These sections can be used independently if the application dictates.

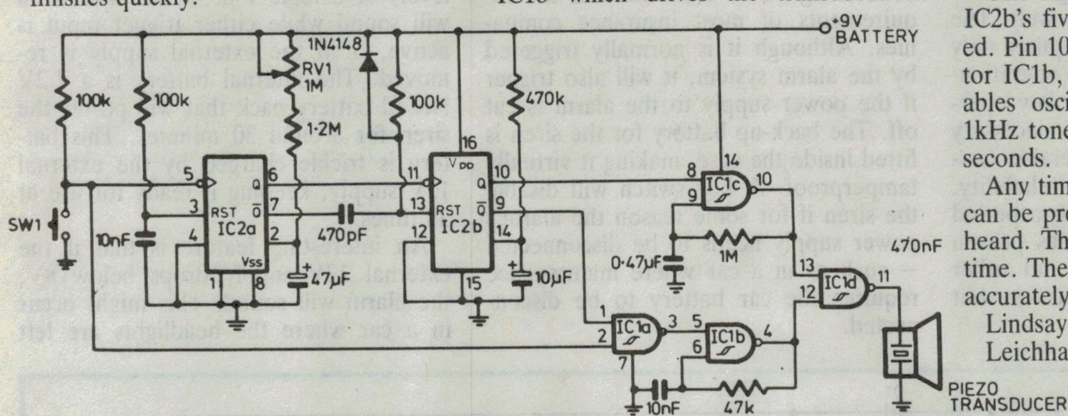
If a different step-up transformer is used, remember to check the secondary voltages so that components are not overstressed. (Conversley, the operating voltage may need to be increased in order to get a sufficiently high secondary voltage).

Phillip Seeley,
Westmead, NSW.

$40

Resettable games timer

I recently purchased a game of Pictionary and found using the egg timer annoying because it was hard to watch it and concentrate on the game at the same time. Also the egg timer can't be reset when a segment of the game finishes quickly.



This circuit has audible indication of time finished and the timing is reset at any time when the switch is pressed. No on/off switch is needed.

Initially when power is applied IC2 is reset. When SW1 is pressed IC1a pin 2 goes low and pin 3 goes high, enabling IC1b which drives the transducer at about 1kHz until SW1 is released again. IC2A pin 5 is also taken low, and its one-minute timing cycle is started. Pin 6 goes high and pin 7 goes low. This low resets IC2b, via the 470pF capacitor, in case it was in the middle of a timing cycle.

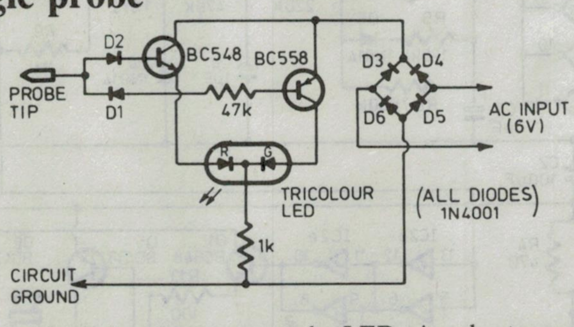
One minute later pin 6 goes low and IC2b's five-second timing cycle is started. Pin 10 goes high and enables oscillator IC1b, while pin 9 goes low and enables oscillator IC1b. The result is a 1kHz tone pulsed at about 2Hz for five seconds.

Any time during the timing cycle SW1 can be pressed again and a beep will be heard. The timing will restart from that time. The one minute time cycle can be accurately set by RV1.

Lindsay Kafer,
Leichhardt, Qld.

$40

Simple logic probe



This logic probe is designed to operate from 3V to 6V and display Hi, Lo and pulse states of the circuit under test. When the probe is brought Hi, D2 conducts, turning the BC548 on and lighting the red side of the tricolour LED. A Lo lets D1 conduct and turns the BC558 on, lighting the green side of the LED. A pulse turns one LED on at a time alternately, at whatever frequency the input signal is. This makes the LED appear orange at 10Hz or so.

Supply voltage is derived from a full-wave rectifier so there is no need to worry about which lead is positive or which is negative. The only bias needed on the transistors is a 47K resistor on the base of the BC558. These components are not critical to the circuits operation and any near replacements should work just as well. The current drain is as follows:

Hi	–	800uA,	@	5V
Lo	–	980uA,	@	5V
N/C	–	550uA,	@	5V

The finished probe fits easily into an empty medium sized 'Hilighter' pen body. When power is connected, the LED will glow slightly orange from leakage current, brightening significantly above approximately 6V. The Hi, Lo and pulse readings, however, are significantly brighter than this slight glow.

Glen Harris,
Townsville, Qld.

$30

Battery powered Alarm Siren

A battery powered siren is often specified by insurance companies, as it solves the problem of an intruder attempting to disable an alarm system by cutting the power off. The siren described in this article is a fully integrated unit which can be triggered by either a positive or negative logic level from an alarm system. As well, it will also turn on if the external supply is disconnected. The sound output is around 120dB, it can be used with any house or car alarm and it is far cheaper than a comparable commercial unit.

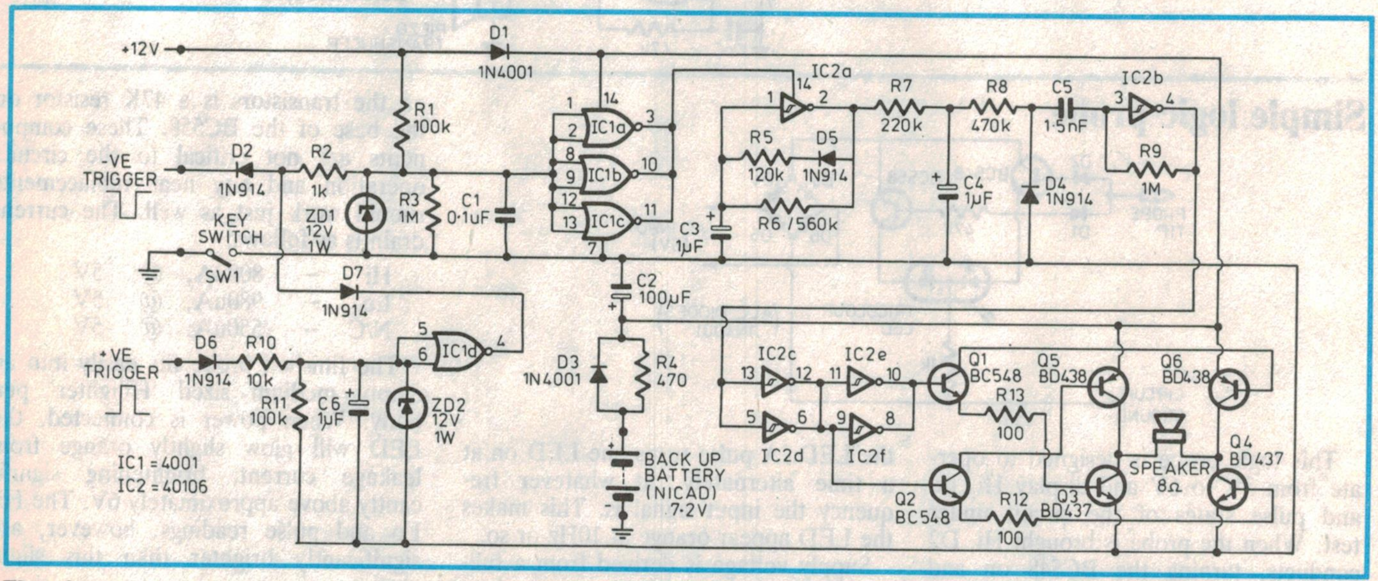
by JEFF MONEGAL and PETER PHILLIPS

This project is actually the final section of our 'Vulture' car alarm system, although the unit can be integrated into virtually any house alarm as well. The siren is self contained and requires only three connections to be fully operational. It has a master over-ride key operated switch, to disable it if necessary and it has undergone considerable testing in the field to ensure its reliability. It has been tested in a car for a period of nearly eight months and has proven to be free of false alarms and other problems. Not good for thieves, but great for security!

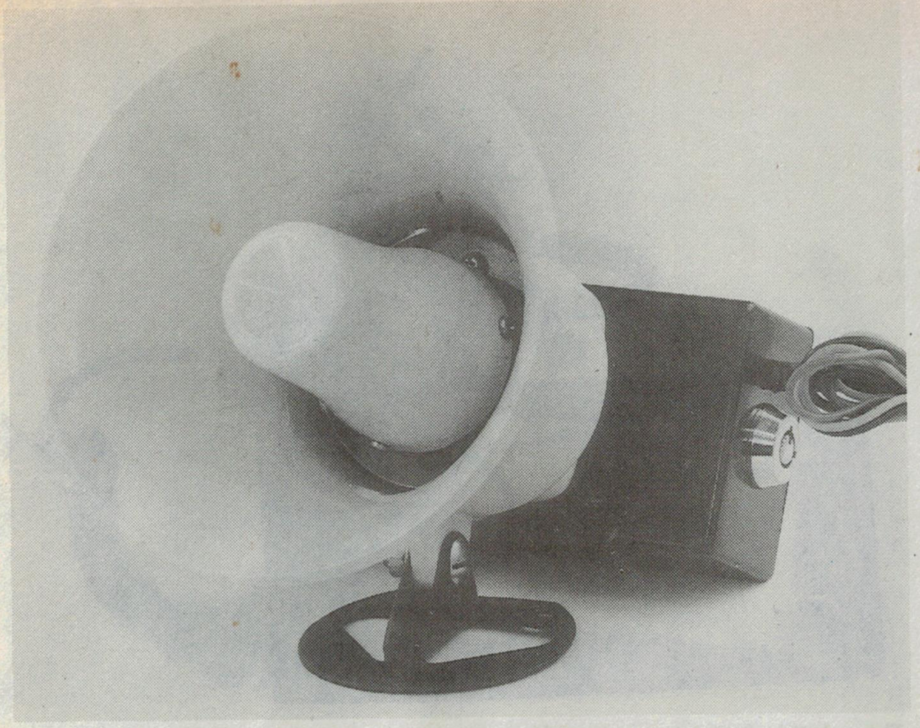
A siren is a very important part of any security system, and this unit has been designed to conform with the requirements of most insurance companies. Although it is normally triggered by the alarm system, it will also trigger if the power supply to the alarm is cut off. The back-up battery for the siren is fitted inside the case, making it virtually tamperproof. A key switch will disable the siren if for some reason the alarm's power supply needs to be disconnected – such as in a car where maintenance requires the car battery to be disconnected.

Triggering by the alarm unit is provided by either a logic 0 (zero volt level) or a logic 1 at +12V. The siren will sound while either trigger input is active, or if the external supply is removed. The internal battery is a 7.2V NiCad battery pack that will power the siren for around 30 minutes. This battery is trickle charged by the external 12V supply, keeping it ready for use at all times.

An interesting feature is that if the external 12V supply drops below 8V, the alarm will sound. This might occur in a car where the headlights are left



The siren sound is generated by the oscillator of IC2a modulating the oscillator of IC2b. The output stage is connected as a bridge, giving nearly 9W of output power. The siren is triggered when the outputs of IC1a to IC1c are high, as power is then supplied to IC2.



Protect your home or car with this self contained siren. It has its own internal battery and makes a lot of noise if the external supply is cut off, or if triggered by an alarm system.

on, giving some degree of warning before the battery goes completely flat. However, if a house alarm has a back-up battery (which they normally do), the siren will not trigger if the mains is cut off, unless the back-up supply falls below 8V.

As mentioned, the siren requires three connections; the positive 12V supply, the trigger input and ground. If a car chassis is used as ground, only two connections are required, making installation a 'snack'.

The whole unit comprises a small printed circuit board, the key switch and the battery pack, which all fit inside a medium size jiffy box fitted to a weatherproof, 8-ohm siren speaker. The recommended speaker will produce an incredible amount of noise when the siren is triggered, even when powered from the internal back-up battery.

The unit is simple to build, and a kit of parts is less than $35 – although this doesn't include the case or the speaker. However these are available from most parts suppliers and a suitable speaker will cost around $14.00 or so, which gives a total cost that is a fraction of a year's insurance. Who was it who said "make life hell for thieves?

How it works

The circuit consists of the triggering network, two oscillators to generate the siren sound, an output stage to drive the speaker and the charging circuit for the back-up battery.

The siren sound is produced by one oscillator frequency modulating another, and the modulating oscillator is formed around IC2a. This oscillator has two feedback networks around the Schmitt input inverter of IC2a, with diode D5 connected so that R5 provides feedback in parallel with R6 when the output of the inverter is high. This gives an output waveform with a high time approximately one fifth that of the low time, and for the values shown the operating frequency will be around 2Hz.

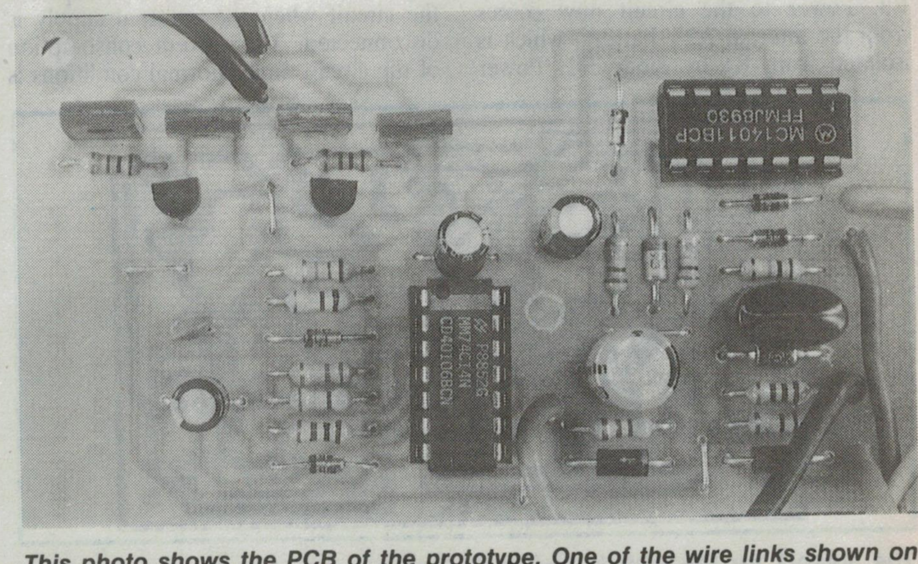
The second oscillator comprises C5, R9 and IC2b, which operates at a higher frequency than the first. The output of IC2a is connected across the integrating network of R7 and C4, giving a sawtooth waveform across C4 while IC2a is operating. This voltage is connected to the input of the second oscillator via R8, causing its frequency to vary as the voltage across C4 varies. The effect is the characteristic wail that is so essential to attract attention.

The output of IC2b connects to the inputs of IC2c and IC2d, which provide drive signal to Q2 and an input signal to IC2e and IC2f. These latter two inverters provide a signal for Q1 that is 180° out of phase with that for Q2. The output stage consists of the bridge connected transistors Q3 to Q6.

When the output signal of IC2b is positive, the signal to Q1 will also be positive (12V) and the signal to Q2 will be zero. This will hold Q2 off and turn Q1 on, causing base current to flow in Q6 and Q3. As a result, almost 12 volts DC will be applied across the speaker, with the positive potential at the collector of Q6.

When the signal reverses polarity, Q1 will be turned off and Q2 on. This time, Q5 and Q4 turn on, while Q3 and Q6 turn off. The voltage across the speaker will again be around 12 volts, but now of the opposite polarity to that for a positive input signal.

Therefore, the peak to peak signal across the speaker is around 24V, giving an RMS power output of approximately 9W for an eight-ohm load. A bridge configuration such as this gives four times the power output, compared to a



This photo shows the PCB of the prototype. One of the wire links shown on the layout was fitted to the underside of the prototype.

output stage driving a load connected to the common rail.

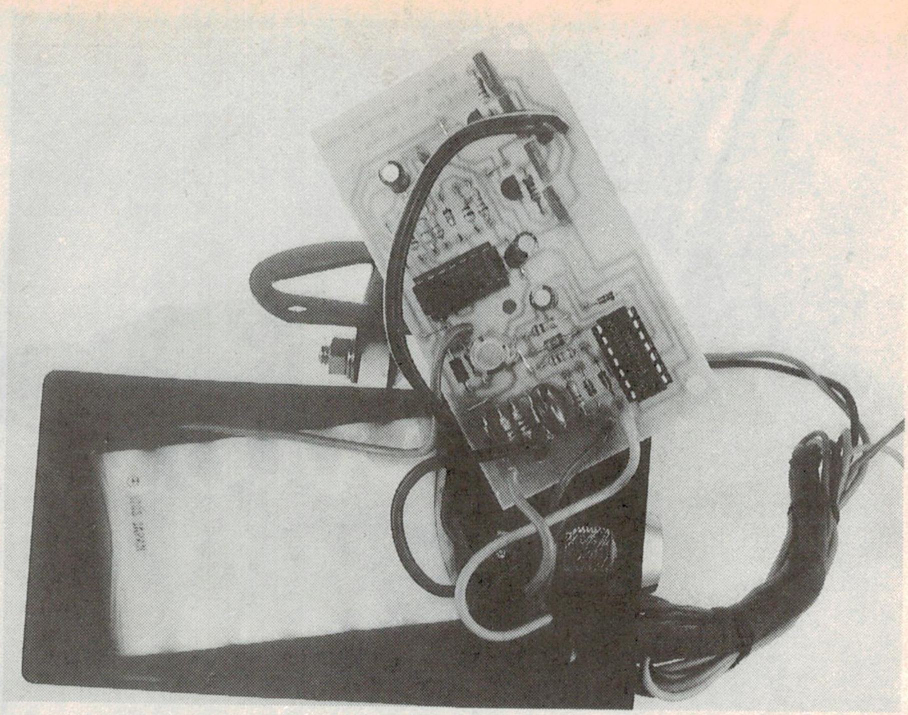
The output transistors are specified as BD437 and BD438 types, chosen because they have a low saturation voltage and a current capability of 4A. Many commercial sirens use the same transistors.

The siren will operate only when the outputs of the parallel connected NOR gates (configured as inverters) of IC1 are at a logic 1, as this is the source of DC power for IC2. Because all the inverters of IC2 are powered by a common supply, (at pin 14), if this supply is turned off the oscillators cannot function and there is no drive signal to either Q1 or Q2.

The negative trigger input is connected to the cathode of D2 and if this input is at zero volts, the inputs of IC1a to IC1c will be pulled low. Under this condition their outputs will be high, supplying power to IC2 which then causes the siren to operate as already described.

The positive trigger input is at the anode of D6 and if this input is connected to 12V, D6 will be forward biased and the inputs of IC1b will be at a logic 1. As IC1b is connected as an inverter, its output will be a logic 0, which will forward bias D7 – giving a logic 0 to the inputs of IC1a to IC1c. Thus as already described, power is supplied by these gates to IC2, again setting off the siren.

If the external 12V supply is disconnected, R1 will no longer be able to hold the inputs of IC1a to IC1c high, and these inputs will be pulled low by R3. Power to the circuit now comes from the internal 7.2V battery, which is isolated from R1 by diode D1. Power will again be supplied to IC2 by the gates of IC1a to IC1c, and the circuit will now operate until the internal battery is exhausted. The output power will be around 3W, but the sound level at this power is still substantial. Also, the operating frequency of the oscillators will be slightly different due to the lower supply voltage.



This photo shows how everything fits inside the jiffy box. The battery pack lies on the bottom of the box, and a piece of insulating material should be placed between it and the PCB.

The zener diodes ZD1 and ZD2 protect the inputs of IC1, and filtering is provided by C1 and C6 to prevent transients sounding the alarm. The back-up battery is trickle charged by R4, and diode D3 allows this battery to power the circuit when the external supply is disconnected. The current consumption of the circuit under normal conditions is therefore the charge current for the back-up battery, which will be around 10mA for an external supply of 12V.

The key operated switch is connected in series with the common line of the circuit, which allows it to silence the siren under all circumstances as it switches both the internal and external supplies.

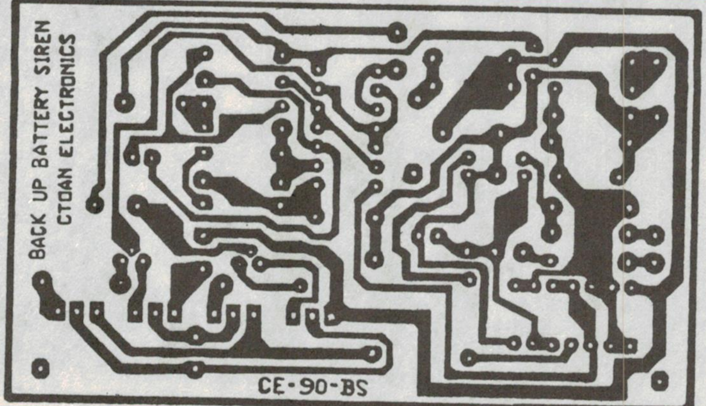
Construction

A kit of parts for this project is available from CTOAN Electronics for $34.95. (See details at end of this article).

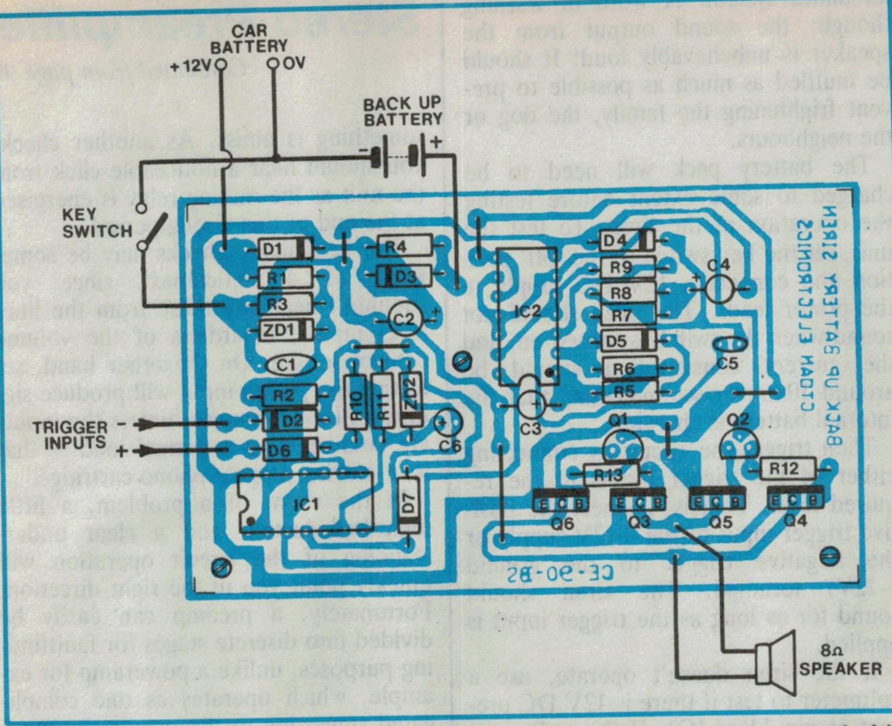
Construction of the project comprises stocking the PCB and fitting the speaker to the case so that the wiring to the speaker is hidden. A hole in the case is required for the key operated switch, alongside another hole as an exit point for the connecting wires.

Start by checking the PCB for any faults, then fit the six wire links. Next mount and solder the resistors, followed by the diodes and the capacitors, taking the usual care with the orientation of the diodes and the electrolytic capacitors.

The four power output transistors are in the TO-126 package, and they all face the same way on the PCB with the metallised section facing to the centre of the board. The base connection is the lead on the right when looking at the plastic area of the body of the transistor, with the leads pointing downwards.



The artwork for the PCB is reproduced full size, for those who can etch it themselves.



The layout diagram for the siren. The output transistors have the metal side facing towards the centre of the PCB. Use heavy duty wiring for all connections.

The ICs can be mounted directly on the PCB, although sockets were used in the prototype.

Once the PCB is completed, the case should be prepared by drilling holes for the key switch (approximately 17mm) and the exit point for the external wiring. When these holes are drilled, the speaker can be fitted to the case. When drilling the hole for the key switch, drill successively larger holes, then file the hole to the correct size. This will minimise the possibility of cracking the case.

The speaker should be mounted so that its connecting wires are hidden, to prevent a resourceful intruder from cutting them. The way you chose to fit the speaker will depend on the type of

Does it conform with noise pollution laws?

Car alarms, like any noise source, must comply with noise pollution laws. The regulations are fairly complex and are listed in Section 126-1 of the Environmental Noise Pollution Manual, clauses 33(a) to 33(f). Clause 33(b) states that a car alarm should not sound for more than 90 seconds unless it is triggered by an open door (and sun roof etc.), broken window, attempt at illegal entry or if the vehicle is involved in an accident. In these cases there is no time limit. Clause 33(e) states that the alarm output should not exceed 115dB at one metre, with the car bonnet closed.

For this project, the car alarm itself determines how long the siren sounds, and the sound level of the siren is around 112dB, meaning it complies with the regulations. The only grey area concerns the possibility of the siren sounding if the car battery is flattened by lights left on, or for other reasons. In this case, the siren will remain on until its internal battery is exhausted, which takes around 25 to 30 minutes. From what we can determine, commercial alarms operate in the same way, and these have all been approved.

The regulations also state that if a complaint is registered about a car alarm, the police will require the offender to disconnect the alarm, then have it tested at an approved testing station. Apparently, a fine is only levied where the offence occurs frequently and the owner takes no action to prevent it.

If you are concerned about the siren going off should the battery voltage fall significantly (to around 6V), a simple modification can be made that disables this function. In this case, remove R3 and reconnect R1 to the cathode of D1 rather than its present connection at the anode of D1. The siren will now sound only if the alarm is triggered, assuming the 12V supply is still available for the alarm module. The siren will still operate from its internal battery as described.

If you still aren't sure, CTOAN Electronics will answer any questions concerning the regulations involving the siren. In particular, the laws governing house alarms are different to those for a car alarm, and without spelling them out, the siren complies with these regulations in all respects.

PARTS LIST

1	PCB 90 x 53mm, coded CE90BS
1	7.2V NiCad battery pack
1	SPST key operated switch
1	8-ohm horn speaker (Jaycar type AS-3180)
1	Plastic jiffy box, 41 x 68 x 130mm

Hookup wire, etc.

Resistors

All 1/4 watt 10%:

R1,11	100k
R2	1k
R3,9	1M
R4	470 ohms
R5	120k
R6	560k
R7	220k
R8	470k
R10	10k
R12,13	100 ohms

Capacitors

C1	0.1uF polyester
C2	100uF/25VW electrolytic
C3,4,6	1uF/25VW electrolytic
C5	1.5nF ceramic

Semiconductors

D1,3	1N4001 1 amp diode
D2,4,5,6,7	1N914 signal diode
ZD1,2	12V 1W zener diodes
IC1	4001 quad NOR gate
IC2	74C14 or 40106 hex Schmitt trigger
Q1,2	BC548 NPN transistors
Q3,4	BD437 NPN power transistors
Q5,6	BD438 PNP power transistors

A kit of parts for this project is available from CTOAN Electronics. Cost of the kit is $34.95 (plus $2.50 post and pack) which includes the PCB, key switch, the battery pack and all components. It does not include the case or the speaker. Fully built and tested units (no speaker, but fitted in a jiffy box) are available for $54.95 plus $3.00 P&P. To order, write to or phone:

CTOAN Electronics,
PO Box 33,
Condell Park, NSW 2200
Phone (02) 708 3763

A repair service is available for $10.00 (plus $2.50 P&P), providing the kit has been constructed in a reasonable manner.

Alarm Siren

speaker and the particular needs of your installation. For the prototype, the speaker was disassembled and the connecting leads were run through a hole drilled in the rear of the speaker's case.

To achieve this, the manufacturer's sticker needs to be removed from the rear of the speaker to expose the single bolt that holds the voice coil assembly inside the case. By removing this bolt, the voice coil and magnet assembly can be removed from the case (carefully!) and a hole for the wires drilled in the case alongside the existing hole for the bolt. The wires are normally passed through a slot next to the mounting bracket on the case, and they need to be pulled free of this slot to completely remove the voice coil assembly.

The jiffy box can be attached to the speaker case by either the single bolt holding the voice coil, or with two self-tapping 'PK' screws into the rear of the speaker case. Either way, at least one other hole will need to be drilled in the jiffy box to line up with the hole for the wires to the speaker.

If you don't wish to dismantle the speaker, the wires can be glued to the outside of the speaker case then passed through a hole in the base of the jiffy box. In this instance, the speaker can be attached to the box with two 10mm-long self-tapping screws, by drilling holes into the rear of the speaker's case. Just be careful when you drill these holes to avoid contacting the voice coil magnet.

Once the speaker is attached to the box and the key switch has been mounted, their connecting wires can be soldered to the PCB. The battery pack lies under the PCB on the bottom of the jiffy box, connected to the PCB with short lengths of hookup wire. A piece of cardboard or similar insulating material should be placed between the battery pack and the PCB, to prevent it or the components coming into contact with the battery terminals or the case of the battery pack. The PCB can be mounted with the components facing either way, although face down is probably the easiest.

Finally, run the three external wires through the exit hole drilled in the jiffy box. The trigger wire will need to connect to either the positive or negative trigger input, to suit the output of the alarm system you are using.

Testing

Once the unit has been completed, it should be tested before being fitted to an alarm system. A word of warning though: the sound output from the speaker is unbelievably loud! It should be muffled as much as possible to prevent frightening the family, the dog or the neighbours.

The battery pack will need to be charged to some extent before testing the operation of the siren. To test the unit, set the key switch to the 'off' position and connect a 12V DC supply to the power leads. The siren should not sound when the switch is turned on, and the current consumption should be around 10mA or so, indicating that the internal battery is charging.

Then trigger the circuit by connecting either of the trigger inputs to the required level. That is, connect the positive trigger input to the +12V supply or the negative trigger to the ground (–12V) terminal. The siren should sound for as long as the trigger input is applied.

If the siren doesn't operate, use a voltmeter to test if there is 12V DC present at pin 14 of IC2. If this voltage is present, measure the DC voltage across C4 to determine if the modulating oscillator is operating. A zero reading will indicate this oscillator is not functioning, although this will not prevent the second oscillator from operating.

The amplifier and output stage are very simple, and DC voltage tests should quickly determine why the unit is not functioning. The usual faults are transistors around the wrong way, a missed connection or wrong value components. If all else fails, CTOAN Electronics offer a fault finding service for a nominal charge (see end of article).

If the siren is operating from the trigger inputs, the next check is to see if it sounds when the external supply is disconnected. As already mentioned, the internal battery will need to be charged for this test. The sound output will be different to that when the siren is operating from the 12V supply, both in frequency and in level. It should still be very loud however – enough to warrant the previously mentioned muffling.

Once satisfied that the siren is functioning correctly, the lid of the jiffy box can be attached and the unit fitted to the car or house alarm it is intended for. For best protection connect the siren to the alarm module with multi-cored cable (twin or three core), as cutting the trigger wire only will disable the trigger without setting the siren off. This way an enterprising wrong doer who thinks a pair of side cutters is the answer will soon find out that he (or she) made a big mistake.

Stereo Preamplifier

Continued from page 99

something is amiss. As another check, you should hear a noticeable click from the unit as the muting relay is energised at the end of this timing period.

The headphone checks may be somewhat of a anticlimax, since you shouldn't hear any noise from the line-level inputs, regardless of the volume control setting. On the other hand, selecting the phono input will produce significant levels of noise, unless the inputs are connected to a normal load – that is, a moving magnet phono cartridge.

In the event of a problem, a little logical deduction and a clear understanding of the circuit operation will quickly point you in the right direction. Fortunately, a preamp can easily be divided into discrete stages for faultfinding purposes, unlike a poweramp for example, which operates as one complicated stage due to the overall feedback loop.

If the preamp is complete and you have to gain access to the component side of the PCB, there should be enough length in the mains wiring to unbolt the bottom panel and rotate it out of the way. Bear in mind however, that the mains earth is connected to the bottom panel and will no longer be connected to the remaining chassis panels. If you need to apply power, temporarily install a clip-lead between the main earth bolt and the unearthed chassis – it's best to play safe.

Clicks, pops & hum

When it comes to using the preamp in the real world, things invariably become a little more complex due to the earthing anomalies and interference created by ancillary equipment. It would be quite frustrating to build a preamp with the exceptional noise figures of the Pro Series Two, only to have the final signal shrouded in noise caused by the rest of the system.

In this regard, we have arranged the preamp circuitry to be floating above the mains earth, avoiding the most likely earth loop problems with the associated power amp, which should have its circuitry referenced to earth. However, if any of the signal sources are also tied to the mains earth, an annoying low-level hum can develop. While conducting performance trials with the Pro Series One power amp, we found that inserting a 1 ohm 10W resistor in series with the link between each

poweramp PCB and the chassis greatly reduced these problems.

On the click and pop side of things, the most likely form of interference is from the action of the power amp's power switch. The best cure in this case is to install a 10nF mains-rated capacitor across the offending switch, which helps to dampen the back EMF (and its associated radiation) from the transformer's primary winding. The combination of the Pro Series preamp and power amp has no problems in this regard, and will power up and down with very little audible effects – the capacitors are not required for either unit.

A secondary form of interference can often come from transients created by electric motors cycling on and off – the household refrigerator is a common culprit. While this type of problem can usually be cured at the source, we found the new preamp to be extremely resilient to both this and pure RF-based interference – presumably due to the uncommonly low impedances used throughout the circuitry.

Unlike many other power amp/preamp combinations, we also found no audible side effects (that is, hum) from stacking the preamp directly on top of the poweramp. This is a further advantage of toroidal transformers, as used in both units.

As a final point, if you find that the headphone outlet has insufficient gain for an unusual type of headphones, simply decrease the value of R29 until a comfortable level is found. However, there is a strict limit to the maximum gain you may use.

This is because if you are listening to the main output via a power amp and speakers, and the headphone amp is set to a high gain, it may be driven into hard clipping while the main output is still well within its limits. Now if IC4 is grossly overloaded, it begins to draw significant input current via R28 in sympathy with each clipped peak, which in turn creates a nasty interference signal at the main output. Nevertheless, you can modify headphone amp gain up to a figure of around five, and still maintain the output's very low distortion figures – provided the power amp has a nominal input level of 1V or less.

That's it. If you have built both the Pro Series One power amp and Pro Series Two preamp, you will find that their performance will rival many of the most expensive commercial preamp/poweramp combinations.

Construction Project:

Applications for our 3.5-digit Panel Meter

In response to reader requests, we describe two applications for the popular digital panel meter presented in June. The first is a temperature probe, and the other is a circuit to allow the meter to be operated from a single supply rail, such as in a car.

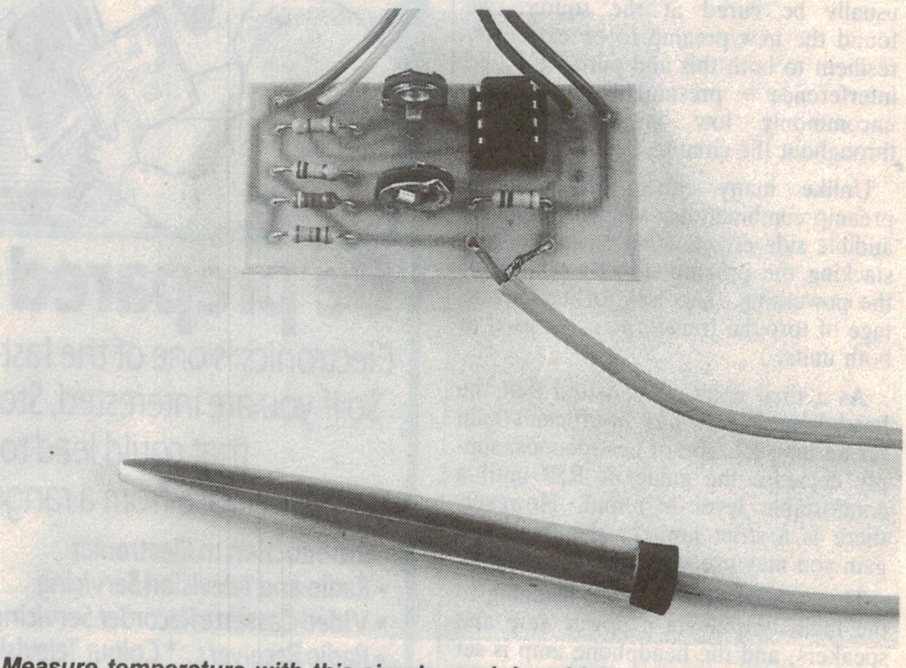
by JEFF MONEGAL and PETER PHILLIPS

Temperature probe

The circuit for this application is shown in Fig.1, and like many DVM temperature probes, it uses a diode as the sensing element. The prototype was tested within the ranges of 0 to 100°C and was found to have good accuracy and linearity. The circuit can be assembled on Veroboard or a PCB, as shown in Fig.2. All parts are bog standard and are available from CTOAN electronics as a kit if required.

Silicon diode D1 is the temperature sensing element and is supplied with a forward current by R1. The voltage drop across a forward biased silicon junction varies by 25mV/°C, falling as the temperature rises and is quite linear over a reasonable temperature range.

In this circuit an offset voltage is provided by VR1 to the op amp, so that zero voltage is present at the output of the circuit when the probe is measuring 0°C. Resistors R3 and R4 limit the adjustment range to make calibration less



Measure temperature with this simple module, which connects directly to the digital panel meter described in June, 1990.

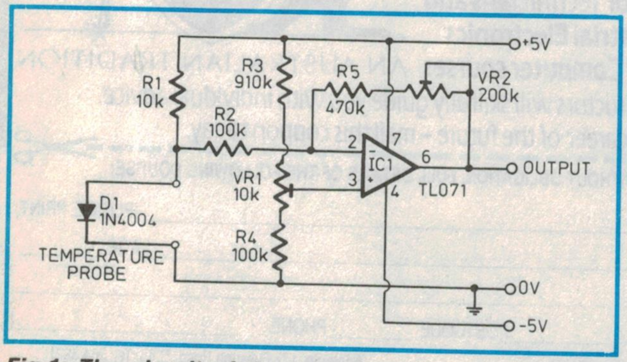


Fig.1: The circuit of the temperature probe uses a diode as the temperature sensor. VR1 sets the minimum value and VR2 the maximum value. Measurement range is approximately 0 – 100°C.

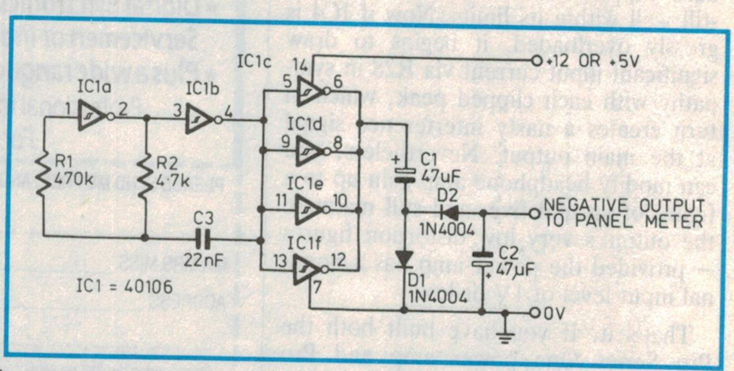
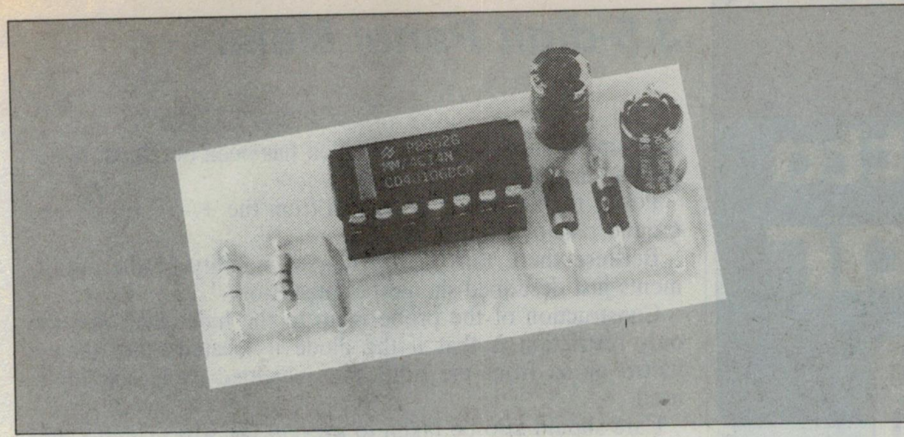


Fig.3: The circuit diagram of the negative rail generator. The oscillator around IC1a and IC1b is buffered by the remaining gates, which pump charge into C2 via the diodes and C1.



The negative rail generator is small enough to be fitted inside the enclosure of the digital panel meter, and allows the meter to be powered by a single rail supply.

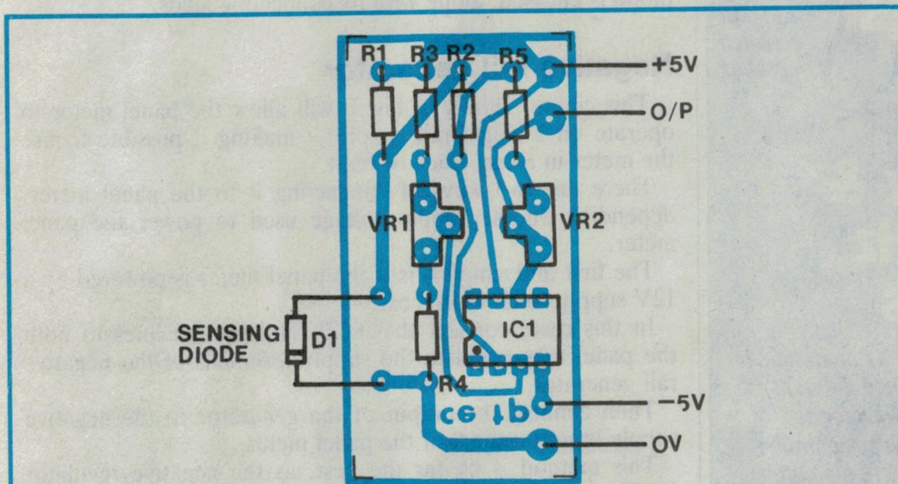


Fig.2: The PCB layout for the temperature probe. Use shielded cable if the probe lead is more than a metre long.

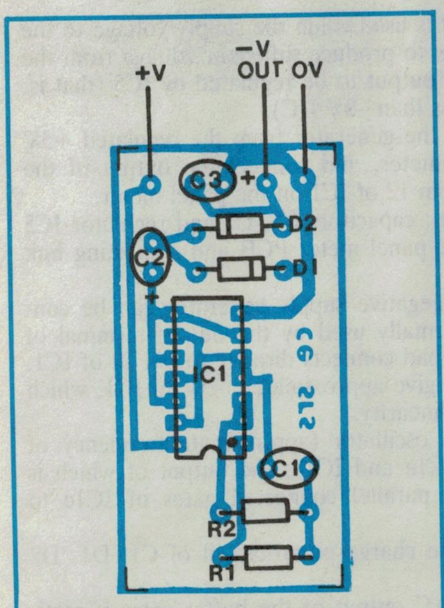


Fig.4: The layout diagram of the negative rail generator.

critical.

The second adjustment is for the upper temperature limit, and is provided by VR2. The op amp of IC1 amplifies the voltage across D1, and VR2 is normally set to give a 1V output when the probe is at 100°C.

Thus, calibration is achieved by first immersing the probe in icy water while adjusting VR1, then with VR2 when the probe is placed in a container of boiling water. It may be necessary to trim each

Parts list for temperature probe

All resistors 1/4 W

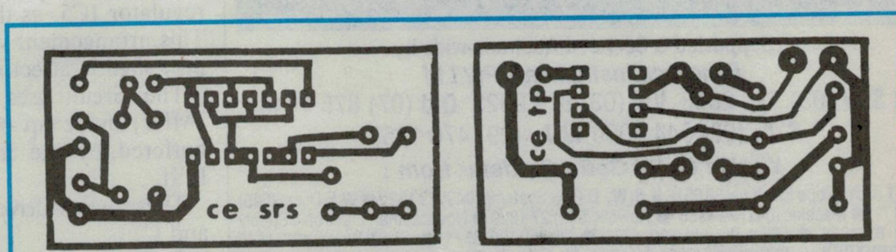
R1	10k
R2,4	100k
R3	910k
R5	470k
VR1	10k trimpot
VR2	200k trimpot
IC1	TL071 op amp
D1	1N4001 silicon power diode
PCB	coded CE TP

Parts list for negative rail generator.

R1	470k 1/4W, 10%
R2	4.7k 1/4W 10%
C1,2	47uF 16V electrolytic
C3	22nF polyester
IC1	74C14 or 40106 CMOS hex schmitt inverter
D1,2	1N4001 power diode
PCB	coded CE 90 SRS

A kit of parts containing the PCB and all components for each circuit is available from CTOAN Electronics. The temperature probe costs $6 and the negative rail generator $5. Add $1 for post and packing in both cases. Kits for the panel meter are also available for $39.95, plus $2.50 P&P. Orders can be mailed or phoned to:

CTOAN Electronics
PO Box 33
Condell Park, NSW 2200
Phone (02) 708 3763



The PCB patterns for both modules are reproduced full size; (a) is the pattern for the temperature probe and (b) for the negative rail generator.

adjustment until overall calibration has been obtained, by repeating the process several times.

Power for the circuit is derived from the +/–5V supply and ground rails of the panel meter.

Because these rails are regulated, stability of the adjustments just described should be satisfactory.

Construction of the probe is up to the individual, and the only restriction is that if the diode is located more than a metre or so from the unit, then shielded cable should be used.

Care should also be taken to prevent the wires coming into contact with any liquid that conducts electricity, as this will affect the operation of the circuit.

A temperature probe can be constructed in which the diode is encased, along with its connecting leads.

Negative rail generator

This circuit, shown in Fig.3, will allow the panel meter to operate on a single rail supply – making it possible to use the meter in a car, truck or boat.

There are two ways of connecting it to the panel meter, depending on the supply voltage used to power the panel meter.

The first and simplest is if the panel meter is powered by a 12V supply, such as in a car.

In this case, connect the +12V and ground lines to both the panel meter and to the supply terminals of the negative rail generator.

Then connect the output of the generator to the negative supply input terminal of the panel meter.

This method is by far the best, as the negative regulator (IC5) on the panel meter ensures that the voltage supplied to pin 12 of the ADC (IC1) is ripple free and regulated to –5V.

The output of the generator will be approximately –10V under load, which is more than sufficient to supply the –5V regulator.

The second method is used when the supply voltage to the panel meter is too low to produce sufficient voltage from the generator to allow its output to be regulated by IC5 (that is, when the output is less than –8V DC).

In this case, power the generator from the regulated +5V supply on the panel meter, and connect the output of the generator directly to pin 12 of IC1 on the panel meter.

With this connection, capacitors C5, C7 and regulator IC5 are removed from the panel meter PCB and a shorting link is put in place of C5.

The output of the negative supply generator can be connected to the pad normally used by the output terminal of regulator IC5, as this pad connects directly to pin 12 of IC1. This arrangement will give approximately –3V to IC1, which may slightly affect its linearity.

The circuit uses an oscillator (approximate frequency of 1MHz) made up of IC1a and IC1b, the output of which is buffered by the four parallel connected gates of IC1c to IC1f.

These gates drive the charge pump circuit of C1, D1, D2 and C2.

In this section the AC output of the buffer gates is rectified by D1, giving a negative potential at the anode of D2.

This diode allows C2 to charge, without being discharged back through the driving circuit.

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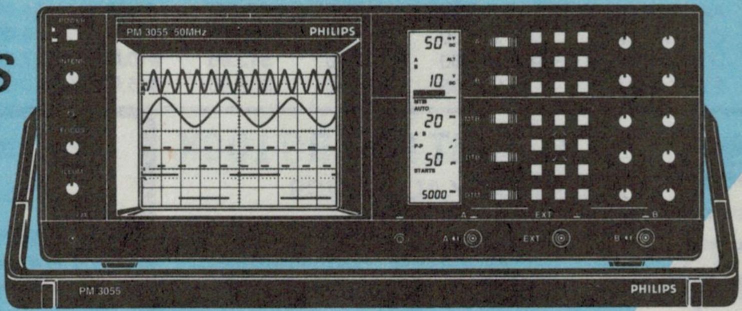

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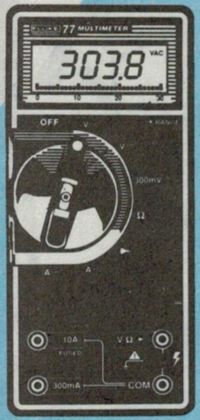

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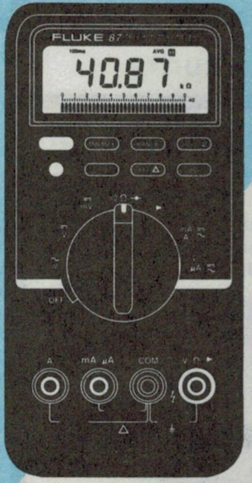

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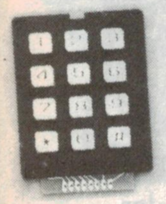

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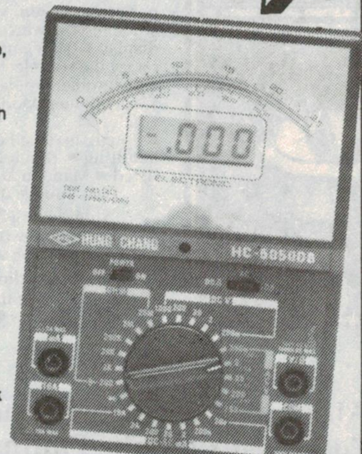

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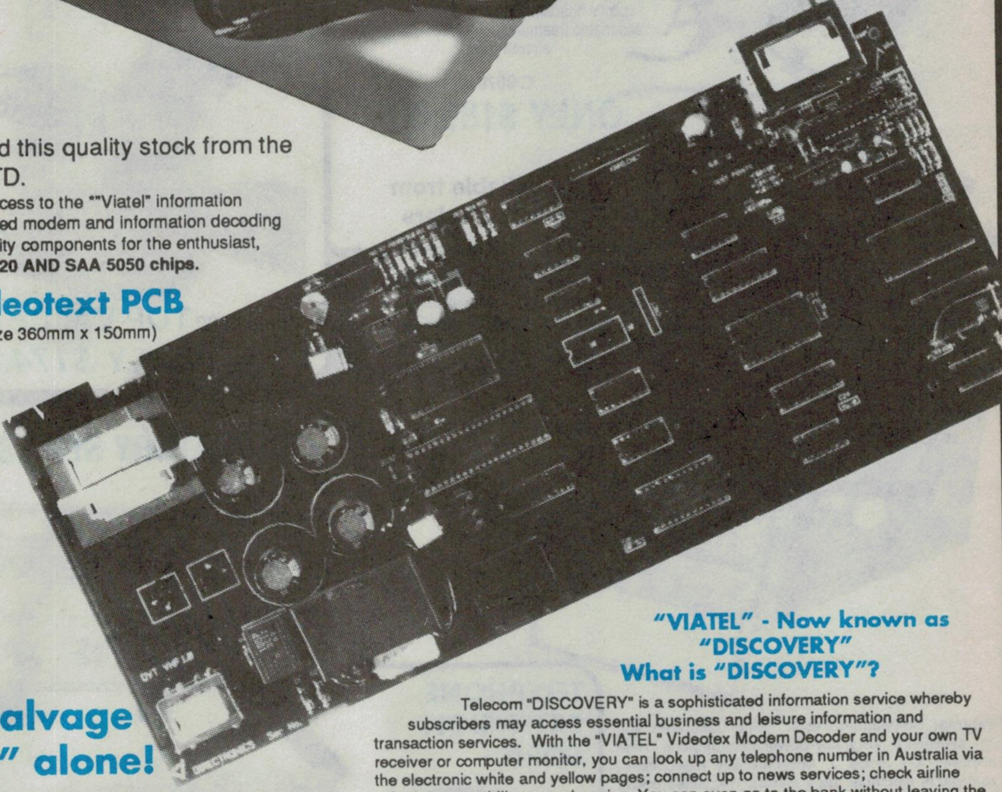

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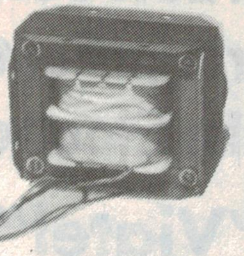

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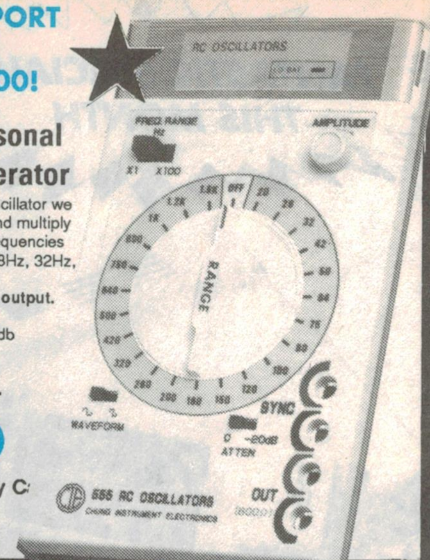

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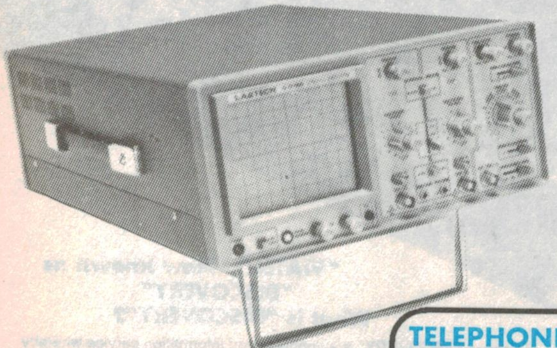

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Description: This model is a dual trace 20MHz Oscilloscope using a high brightness CRT. The vertical amplifiers have high sensitivity of 5mV/div and a frequency characteristic response with smooth roll off exceeding 20MHz. The highest triggering sweep speed is 0.2uSec/div. For component tests, a special circuit is designed, with which a single component or components in or out of actual circuit board can be easily tested, requiring no power to drive the circuit. The display shows fault of component value, characteristics of component, and half-dead components under dynamic test.

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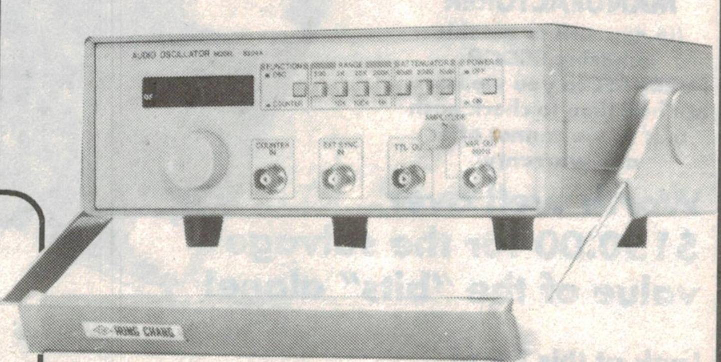

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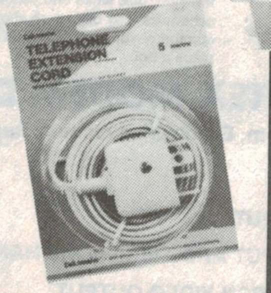

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Q 1547 $480 **PROFESSIONAL VALUE**

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The Serviceman

Out on the water, up in the roof and peering inside a power tranny...

Since our appeal for contributions a few months ago, we seem to have had more 'Contributor's months' than stories from my own workshop. I don't know about you, but I don't mind this a bit – because I enjoy reading about what other people are doing.

Actually most of the contributions that have come in refer to fields of endeavour that are outside my experience, so I also learn about other people's problems and how they solved them. I hope you find this as interesting as I do. Like our first story this month, from L.K., of Daintree in North Queensland.

L.K. is not a newcomer to these pages, and he always seems to come up with a story that is 'more than usually unusual'. This time he writes about 'The Phantom Fuse Blower':

The piece of gear concerned was a marine HF transceiver, which came to my shop in the arms of the owner – who still had some of the mystified expression which, earlier in the day, must have been most pronounced.

A regular customer, he insisted upon talking to me personally. Inexplicably, he arrived at a convenient time – between breakfast and morning tea and shortly after I had completed the last of the urgent work. These sort of jobs usually appear just as the roof falls in.

To start at the beginning, he was a keen amateur fisherman and recently had disposed of his fibreglass boat in favour of an all-aluminium cruiser which apparently came complete with most of the required electronics; the exception being an HF radio. This had to be purchased under separate order, with a two-week delay on delivery.

As his existing unit had proved adequate, he elected to transfer it from the old boat to his latest acquisition. Being a capable man, he had completed this installation himself the previous day and tested it successfully in preparation for the following morning's fishing.

It came as a great surprise therefore when the next morning he pressed the engine starter, only to hear a crackle then see smoke emanating from the transceiver. That mystified look came a little later however, when he realised that the set was not turned on, nor had it blown a fuse. Adding to the confusion was the knowledge that it was in fact connected to its own separate battery.

At this point he decided to seek my help!

I suggested that we adjourn to the workshop and do an inspection, to see just what had happened. With the covers removed it was not a pretty sight. Several tracks had virtually evaporated, leaving globules of copper splattered far and wide. After several minutes of cleaning up the solitary board, the damage became clearer but the cause more remote.

The negative supply line came to one point on the PCB (unlike most sets of this type that I have encountered) then went off in various directions, connecting with the metal frame at four screw points. It was these tracks which suffered the burnup, prompting questions of reversed polarity.

My reasoning was that if the negative lead was somehow linked to battery positive, (with the battery negative to ship's frame) it could explain the evidence. But the customer was most adamant that no such event could have occurred. He emphasised again that he had operated the set the previous day and nothing had been changed since then.

For the moment I had to admit defeat. I suggested that he leave the set with me to do the best I could with a repair, and if, as I suspected, no other damage was sustained, I would accompany him to his boat the next morning to try to resolve the matter. I also hoped that given more time and enough coffee, I could perhaps discover some other reason for the trouble.

The repair proved to be easier than I first expected. In just over an hour I had cleaned up the mess, bridged the damaged tracks and even found some shellac to touch up the bare sections. Next, I hooked up to a 12V supply, connected a dummy load and was pleased to see that it performed more or less as one would expect.

Giving the symptoms some further thought over another 'cuppa' left me still convinced that, despite the owner's insistence to the contrary, some type of wiring error existed on board.

Next morning, on the boat, I first checked the polarity of the black and red leads to which the two-way had been connected. No fault there. The multimeter read 12V between them and also between frame and red. Just as a precaution, I also measured zero volts between frame and the black lead.

The next step was to refit the radio and see what happened under various conditions. (I will admit though, that at this point I was beginning to wish I had left it well alone.) Just as an extra precaution, I installed a fuse in the negative

line. (There was already one in the positive line.) When I switched on the speaker came to life and everything appeared normal.

I turned off again, hooked my meter across the power cable on the battery side of the fuses and requested the owner to engage the starter. The engine fired and the multimeter never flickered – but the precautionary fuse in the negative line blew immediately.

All this happened exactly as I had been advised the day before, yet I was at a loss as to how this could be.

"Let's have a look at the other end of the power cable", I said, not really knowing what I was looking for. As we moved toward the stern to remove a hatch cover, I asked why the separate battery for the HF.

"Safety", he replied. "If the main battery goes flat for any reason, I've always got a full one to call for help." As the cover was lifted to reveal both large and small lead-acid batteries, side by side, the germ of a solution began to roll around my head.

The cable in question came directly to the terminals of the smaller battery right enough, but the complete configuration was not that simple, as the accompanying diagram reveals. In order to keep the spare battery charged, it was paralleled with the main one, with a diode in the negative lead to prevent it being discharged by any of the other equipment.

The owner stated that this was exactly the same as on his previous boat and the arrangement had always worked well. But he had overlooked the significance of the non-conductive fibreglass construction. Now, with the all-metal design, and the main negative line bonded to frame it was 'a whole new ball game', as they say.

As the circuit illustrates, the HF transceiver was effectively shorting out the diode by having the chassis connected to ship's frame and the negative lead to negative of the secondary battery – hence both were actually in parallel! No wonder the copper tracks vapourised; they had in fact been set up to carry a proportional share of the starter motor current.

Now everything fell into place and the solution became obvious. All that was needed to send him out for a happy day's fishing was to swap the diode over onto the positive lead, and replace a blown fuse.

There have been several occasions over the years when I have doubted Ohm's Law! Indeed, a couple of times I've felt sure I could prove it wrong. But this is the only time I can recall being face to face with what looked like an impossible situation, and only two wires to play with!

Thanks, L.K. I can quite understand the confusion that this problem caused. I have never been involved with marine electronics, but I can recall similar confabulations with car radios and the like. (Back in the days when I did car radios, that is!)

Grainy joints

Anyway, on now to our next contributor, who is P.C. of Cambridge, New Zealand. P.C. is the second of our Kiwi contributors in recent months. It's nice to know that my humble scribblings have an international appeal. P.C. writes about one of my own contributions:

Your story in the February 1990 issue of EA about 'coarse, granular' soldered joints on the AWA/Mitsubishi remocon board prompts me to write with a layman's explanation as to why an apparently mechanically solid connection displays odd characteristics.

My involvement with electronics is that of an enthusiastic constructor of nearly 20 years – fixing other people's castoffs from garage sales being the current craze.

Naturally, my theory relates to one such piece of equipment, to wit an aging reel-to-reel stereo tape recorder in need of new heads. Now, in mounting these replacement heads the connecting wires were removed several times. The penultimate time resulted in heaps of hum and feedback in one channel.

Much probing led me to a particular screen connection on a piece of coax cable. This particular connection had been removed several times and the solder had become coarse and granular, in the manner of a joint subject to such treatment.

DC measurement showed a perfect joint, yet bridging the tag and the screen itself with a crocodile clip instantly removed the hum and feedback. Winding the oscilloscope up to its maximum sensitivity suggested that the joint was rectifying the minute currents flowing in the screen.

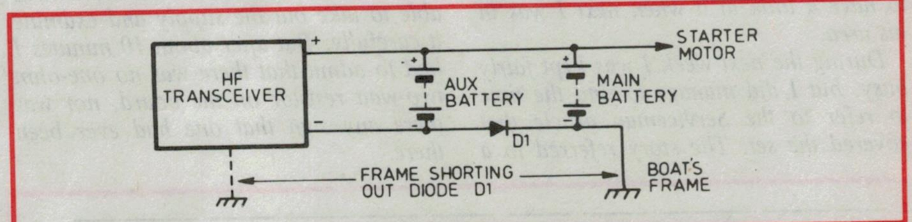
I say 'suggested' as the trace on the scope, even though connected to a nominal earth point, was very noisy and it looked like a rectified waveform was buried in the noise. Needless to say, resoldering with 'new' solder fixed the problem and showed only noise on the scope.

My theory is that these granular joints form mini diodes, which in high current circuits are simply 'bulldozed through', but in lower current/high impedance circuits they can add a circuit element that was definitely not designed in!

Another fault I would like to address is not electronic but human – namely the 'Screwdriver Jockey'.

Several sets I have repaired have had nothing wrong with them, other than misaligned trimmers, coils etc. The most spectacular of these was undoubtedly the Eddystone EC10 with all 44 (yes, ALL 44!) cores, trimmers and adjusters carefully tweaked out of alignment.

One of the toughest of these jobs was a nice FM stereo receiver/amp that wouldn't receive in stereo and was quite flat on both AM and FM. I had bought it at an auction so I didn't have a chance to find out why all the RF, IF and discrete stereo decoder cores had been 'tuned'.



The power wiring used in L.K.'s story, about the boat transceiver which blew the fuses – even when it wasn't turned on!

For someone like yourself in a professional situation, such a job could be totally uneconomic. But me – I love 'em and I get some great sets for a song!

In conclusion, please keep up the good work. I for one enjoy your column every month.

Thanks for the kind words, P.C. It's sentiments like this that makes the hours of slaving over a hot word processor all worthwhile!

As for your first point, I've had a similar feeling myself. I'm sure that 'grainy' solder acts something like the galena crystals used in my childhood crystal sets.

The only thing about the story in

question is that those particular joints had not been resoldered, but had gone grainy with age. I think they were on the way to becoming fully fledged dry joints of the common type.

Nasty intermittent

Now we come to another story from a non-professional serviceman: S.B., of Cockatoo in Victoria, who points out that although he works in the electronics industry, servicing is not his job. Rather he finds this side of the business to be an interesting hobby. He writes:

My story concerns an HMV model C221 CTV chassis, one of the earliest sets of this brand to be released. The model has featured in these pages before, on two occasions when tube heater voltages resulted in dark or non-existent pictures.

This particular tale opened when a friend commented that his TV had 'packed it in!' When I questioned him about it he said that the picture had gone dark. I remembered the earlier stories (most recently July 1988 – Ed.) *and felt sure that the faults were related. I agreed to have a look at it when next I was in his area.*

During the next week I was kept fairly busy, but I did manage to find the time to refer to the Serviceman article that covered the set. The story referred to a fairly common problem with the chassis, wherein a one-ohm two-watt resistor in the CRT's heater supply filter network goes high or open.

The resistor causes a low heater supply voltage, by effectively removing from circuit the 100uF filter capacitor C118. The resistor is not shown on the circuit diagram, but connects the negative side of the capacitor to ground. The resistor is there to limit the line frequency ripple current flowing through the electrolytic capacitor.

My friend's set was showing all the symptoms of a faulty resistor, so I imagined that it would only be a 10-minute job when I eventually got to it.

After the pleasantries were over, I got to work and removed the back cover. I noticed straight away that the tube heaters were dark, so I knew I was on the right track.

The C221 allows easy access to the various boards because the whole chassis is hinged and locks in the raised position. The switch mode power supply is located in the centre of the chassis, under a substantial metal cover.

Once this cover was removed I was able to take out the supply and examine it carefully. But after about 10 minutes I had to admit that there was no one-ohm two-watt resistor on the board, nor was there any sign that one had ever been there.

"Great!" I thought. "Now I'm right back to square one".

My next step was to make sure that all the circuit boards were pushed well down on their contacts. As I pushed on the picture tube base board, the heaters lit up and the set showed a perfect picture.

At this stage it looked like a simple job after all. I removed the board, cleaned up the contacts, refitted the board and put the set back together.

I left the set running for an hour or so while I sat and talked to my friend. During this time it showed no signs of distress, so I concluded that it was fixed and said my goodbyes.

But a few days later my friend was back on the phone, explaining that the set was back to its old tricks. So I promised to drop around again, as soon as possible. This time I decided to take the set back with me and work on it in my own time, so I loaded it into the car and drove home.

The first thing I noticed when I had the set up and running on the bench was that it was perfect again; no amount of bumping, freezing or heating could make the fault return. I knew by now that this set was going to be a nightmare, and I was beginning to regret agreeing to fix it. But I was stuck with it now, and all I could do was to wait patiently until it decided to fail again.

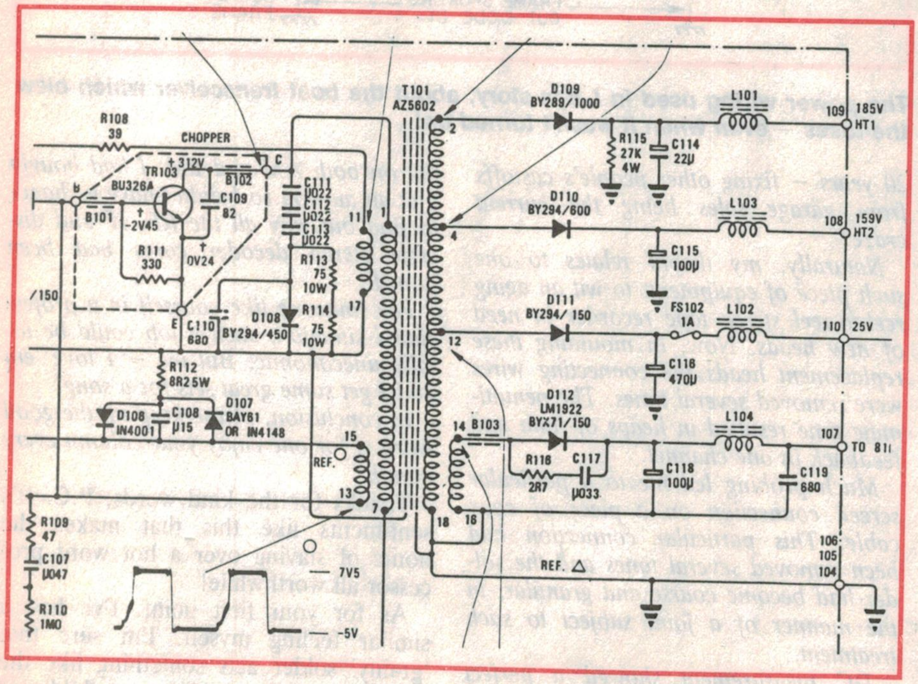
Luckily I didn't have to wait long; soon the heaters had gone dark again. This time pushing the tube base board had no effect, so I can only conclude that it was merely coincidence that it seemed to fix the fault first time round.

My next step was to take a few voltage measurements around the power supply. The heater voltage was down to around 3.4 volts, while everything else seemed normal. Referring to the circuit, I found that the heater voltage is derived from a separate winding on the chopper transformer, which is rectified and filtered by a simple L/C network. There were only six small components in the circuit, so it seemed that as long as the fault persisted, it shouldn't take long to fix.

Once I had found the heater voltage to be low, I knew I was on the right track; but the trouble was that the fault sometimes disappeared for several days at a time. It was a long and frustrating search.

My first line of attack was to resolder every joint in the relevant area, and I also took the opportunity to replace the filter capacitor. But all to no avail.

The fault continued to come and go at intervals of hours or days, and never



The power supply section of an HMV C221 colour TV, which forms the subject of S.B.'s story. The section supplying the picture tube heater is at lower right, involving D112 and C118.

stayed long enough for me to really come to grips with it.

Eventually, I came to the conclusion that it must be a fault in the chopper transformer, although I couldn't imagine what it might be. Each of the secondary windings produced their correct output, except for the heater winding. The heater voltage dropped from 6 volts down to 3 volts when the fault was present.

In the absence of any other faulty component, it just had to be the transformer – but how to prove it was a problem that exercised my imagination for some time.

In the end, I attached two wires to the transformer windings and brought them out from the power supply housing. This allowed me to measure the resistance of the winding without having to disturb anything.

When the set was working normally, the resistance of the heater winding was less than one ohm, as might be expected. However, when the fault was present, the resistance was around four ohms. So in the end, that's what the trouble was.

I replaced the transformer and ran the set continuously for a couple of weeks without any sign of the fault returning. My friend was grateful, but he has no idea of the time and trouble it took to cure his old HMV!

I can imagine just how frustrated S.B. must have been during that job. The trouble with intermittents is that by the time you find out how to make them come and go to order, you have found the cause and thus have no need to make them come and go...

I haven't struck this particular fault in an HMV, but there is one fairly easy solution to any heater supply fault – run it off the line output transformer. I have often used the trick to isolate the heater in sets that have developed a heater/cathode short in the tube.

All that is needed is to loop two or three turns of insulated wire around the ferrite core of the transformer, and take the ends to the heater terminals on the tube base. (If you use this idea for heater isolation purposes, make sure that the heater circuit is not earthed right on the tube base!)

When using this trick it is wise to begin with only two turns of wire, then increase the winding by one turn at a time until the heater reaches normal operating temperature. Because of the spikey nature of the voltage applied to the heater, normal meter readings are not reliable, so it's best to judge the effect by the colour of the heater. Just don't get too enthusiastic, or you'll seriously shorten the life of the tube.

MATV system

Now we come to the last contributor for this month. He is P.L. of Mt Eliza in Victoria, who is a full-time antenna installer. It's some time since we have had an antenna story in these pages, so it's timely to remind ourselves that no amount of careful servicing will be of use to a TV or video recorder if it is not fed with a good signal from a properly installed antenna. P.L. writes:

I was asked to look at a master antenna aerial system which serves seven units in a nearby town. The client's complaint was 'snowy pictures on channels 9 and 10'. My services had been recommended by a local TV retailer, so the client had great expectations. I noticed that their location was behind a hill, perhaps 60km from the transmitters and they had a TL4 aerial installed on a 20-foot free standing mast. The system did not have channel 28.

After a cordial introduction, I disconnected the client's TV from the wall socket and plugged in my field strength meter to check levels. Channel 2 was a healthy 65dB/uV. Channel 7 was just above 35dB/uV, while channels 9 and 10 were just below 35dB/uV.

55dB/uV is the recommended minimum, so it's no wonder she had a snowy picture. In my opinion she should have been unhappy with channel 7, too.

Either the system had never been set up properly, or the distribution amplifier had crashed. My client was in the fifth of the seven home units so I wanted to check the top end of the system, nearest the booster. The people in No.1 said they had always had good reception on all 4 channels but on inspection, their channel 10 had signs of snow too. As they assured me it has been like that since the start, I discounted the faulty amp theory.

The suggestion that I should fit a low-band attenuator and lower value directional couplers didn't impress them at all. So it was back to No.5, where I had been assured the trouble was all hers. When I arrived back at unit 5, the lady's attitude had changed noticeably. Now she was angry and I still had to solve the problem!

By removing a few tiles I was able to slip down into her ceiling where I discovered a 26dB coupler, a ridiculous value for the fifth coupler in a line of seven. They would need over 80dB/uV on all channels in the main trunk at unit 5 to give the required 55dB/uV. I only had 8dB couplers in the van and would have preferred a 12dB to minimize further loss to units 6 and 7. But it would have to do.

I fitted the 8dB unit and went down to look at the results. The lady's attitude now reminded me of the Good Book, where it says 'I will turn your mourning into joy'. Now she had the perfect picture she had sought.

She admitted that I was the 5th tradesman to try to fix her problem, and when I didn't want to see her picture but merely plugged in my little black box, it was more than she could bear. That's why she had got cranky.

But all's well that ends well – or is it? They still have grossly unbalanced levels between bands I and III, no UHF and probably the wrong coupler values throughout the rest of the system. But at least my client is happy...

Thanks, P.L. That story echoes my experiences of multi-outlet systems. One of my more interesting discoveries was that all of those botched jobs were put in either by the electricians when the building was being erected, or by the owner soon after. I never did find one bad system that was installed by an antenna specialist.

Well, that's it for this month. We've been on a boat, inside a TV and up on the roof among the antennas and things. That's not a bad span of subjects, and I defy anybody to be bored with those contributions.

In the meantime, keep those stories coming! Typed and double spaced if you can, or best of all on a floppy disc as per Jim Rowe's notes on page 47 of the April 1990 issue. The less work we have to do on your contribution, the more dollars there'll be on your cheque.

Fault of the Month

GEC 2213A

SYMPTOM: No sound or picture. All fuses are OK and there are 320 volts on the collector of the chopper transistor, TR502.

CURE: R503 (22k ohms) open circuit. This resistor supplies 12V to run the chopper control IC, and in doing so needs to dissipate 4.9 watts. The original 5W resistor is rather underrated and a 10W replacement will ensure more reliable operation.

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Microwave CW transistor

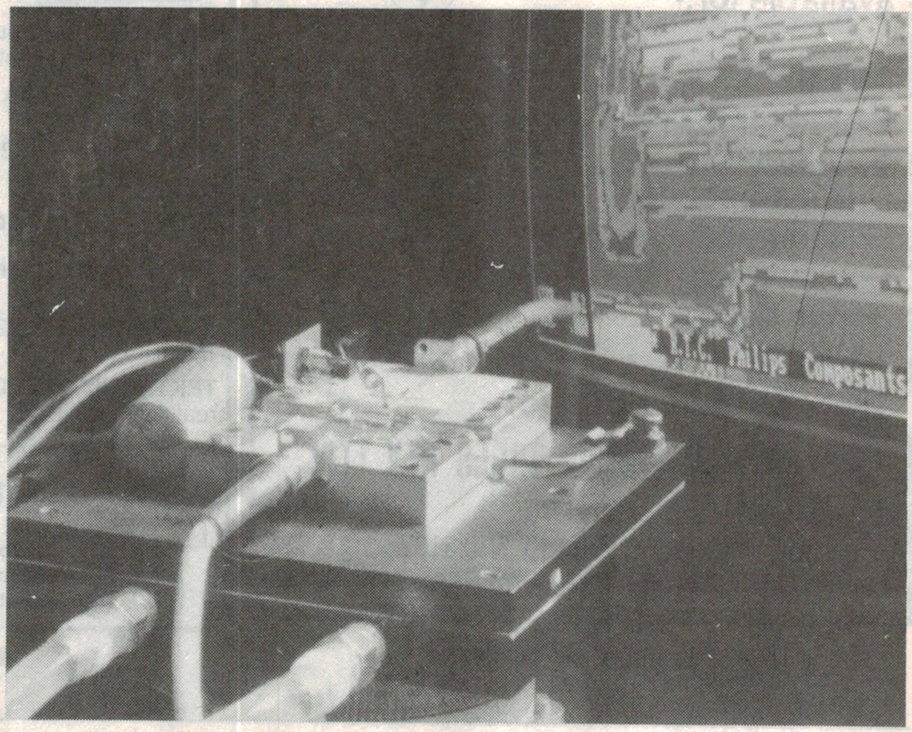
Providing 50W continuous-wave power at 1.6GHz, Philips Components' PXB16050U microwave power transistor is said to deliver the highest output power yet for satellite links in INMARSAT and similar systems.

The non silicon planar epitaxial transistor works in common-base class C narrowband amplifiers, and suits voice and data communications for ships, aircraft and earth stations. An interdigitated emitter structure leads to a collector efficiency as high as 52%, and a low thermal resistance reduces junction temperatures to increase reliability.

Input and output prematching circuits facilitate design of external circuitry and help distribute power equally over the total available active area of the transistors, thus avoiding hot spots.

The transistor operates from a supply voltage of 28V, and has a typical power gain of 9.5dB. The thermal resistance is a low 1.5°/W from junction to mounting base.

Diffused emitter ballasting resistors provide excellent current sharing and improve ruggedness. Gold metallisation ensures that the device characteristics remain stable, and extends the device's lifetime.



The transistor comes in an FO-91 metal-ceramic flange package.

For further details circle reader information service number 271 or contact Philips Components, 11 Waltham Street, Artarmon 2064, phone (02) 439 3322.

64Kbit co-directional interface

Exar Corporation has commenced production of a two-chip set designed to implement a CCITT 64kbps co-directional interface. The chip set consists of an analog tranceiver device, and a digital data processor.

The XR-T6164 is a bipolar analog 16-pin IC, intended for general purpose line transceiver applications. It is designed for short line applications (less than 10dB) at bit rates up to 1.544-Mbps. Typical current consumption is 25mA.

The XT-T6165/6166 are digital CMOS circuits designed to perform the interface function between a 64kbps data stream and a 2.048Mbps PCM timeslot data channel.

Both the XR-T6165 and XR-T6166 include a transmitter which transforms 8 bit 2.048Mbps timeslot data packets into a coded 64kps data stream, and a receiver which performs the reverse function. Repetition or deletion of received or transmitted data when clock skews or transients occur is automatic in both chips, allowing continuous synchronised data transmission or reception.

When the XR-T6164 is used with either the XR-T6165 or XR-T6166, the two chips form a complete co-directional interface which conforms to the CCITT G.703 specification requirements.

For further information circle 276 on the reader service coupon or contact Tronic Bits, 14/260 Wickham Road, Moorabbin 3189; phone (03) 555 6777.

SM wideband directional couplers

Merrimac directional couplers are available in a variety of packages to suit most applications. The 0.25" square surface mount package used in this CBG-A series has been critically designed for 50-ohm coplanar systems to optimise RF performance, while still achieving the small size and low profile of surface mount devices.

The Kovar input leads are designed to suit a variety of mounting situations simply by trimming them to the desired length.

Applications of directional couplers include the monitoring of incident and reflected power, in signal sampling for control loops, as well as test signal injection devices in BITE systems. The couplers may also be used back-to-back. Similar Merrimac couplers may be ordered with specific coupling values up to 30dB, and at frequencies up to 2.5GHz.

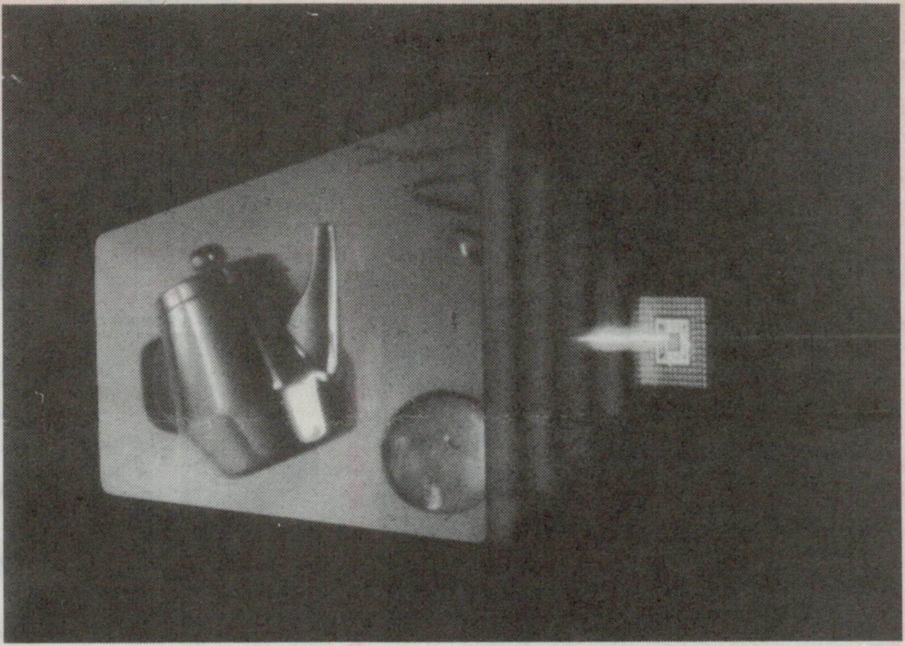
For further details circle reader information service number 272 or contact George Brown Group, 456 Spencer Street, West Melbourne 3003, phone (03) 329 7853.

200MHz CMOS RAMDAC

Brooktree has pushed CMOS technology into the 200MHz domain with the introduction of the Bt468, claimed to be the fastest triple 8-bit RAMDAC the industry has yet seen. It is designed specifically for high-resolution monitors supporting 1600 x 1280 pixels at 70Hz refresh rate.

The use of an 8:1 multiplexing scheme eliminates the need for external multiplexing and latching logic, and simplifies frame buffer design.

The new high speed RAMDAC incorporates many of the same integrated features found in the Bt459, including on-chip hardware cursor, pixel panning, signature analysis registers, and monitor detection circuitry. In addition to a 256 x 24 colour palette, it also provides four planes of overlay memory and two planes of cursor.



The two-plane cursor supports three colours in the standard mode or two colours in the X-window mode. In the X-window mode, the cursor can be enabled or disabled via one of the cursor planes, while the other plane is used to determine the cursor pattern with foreground and background colours.

For further details circle reader information service number 278 or contact Energy Control International, 26 Boron Street, Sumner Park 4074, phone (07) 376 2955.

Infrared remote control transmitter

Philips Components has released an infrared remote control transmitter that operates at supply voltages between 2.5 and 6.5 volts. The circuit can be used to transmit an individual code to a receiver by infrared. The code is stored in the on-chip EEPROM, which is programmed by the equipment manufacturer during production or installation.

The PCF1254 uses fixed frequency data coding and a 22-bit EEPROM code. A few milliseconds after application of the power supply the circuit outputs the preprogrammed 22-bit EEPROM code three times in succession. A sequence of two zeroes is automatically transmitted preceding the 22-bit code.

A Philips low cost microcontroller with on-chip 8 bytes of EEPROM, the PCF84C121, is suited for use as a receiver/decorder with the PCF1254. A member of the PCF84CXX family of microcontrollers, the PCF84C121 also features wide operating voltage and low current consumption.

The PCF1254 is available both in 8-pin plastic DIL (SOT97) and 8-pin plastic mini-pack (SO8: SOT96A).

For further details circle reader information service number 279 or contact Philips Components, 11 Waltham Street, Artarmon 2064, phone (02) 439 3322.

Low on-resistance power MOSFET

Siliconix has released a new 60V, 60A power MOSFET which offers the lowest on-resistance available to date, in a TO-220 package. Built with SiMOS 2.5 technology, which packs 2.5 million transistor cells per square inch of silicon, the SMP60N06-18 is specified with a maximum on-resistance of just 18 milliohms. Thus it offers greater efficiency and performance for battery-operated designs, such as variable speed controls used in rechargeable electric hand tools.

The low conduction losses of the SMP60N06-18 allow smaller heatsinks to be used, thereby reducing the size of the end product. In some cases, where designers have been paralleling MOSFETs to reduce on-resistance, one SMP60N06-18 may be used to replace two power MOSFETs with higher on-resistance ratings. The low gate charge of the SMP60N06-18 (85nC total charge for full turn-on) simplifies driver circuitry, further reducing component count and space requirements.

For variable speed motor controls, the low on-resistance allows higher maximum torque and higher top speeds. The SMP60N06-18 is specified for diode commutation ruggedness, an essential feature for motor control circuits which eliminates the need for external diodes.

For further information circle 284 on the reader service coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 648 5455.

'Super I/O' chip for PC's

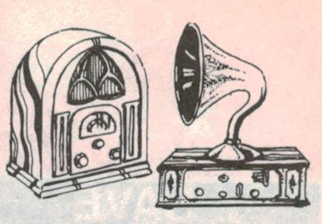
National Semiconductor, in collaboration with ACER Inc. of Taiwan, has made a device which integrates analog and digital technology and combines four basic functions – offering a single-chip solution to the most commonly used IBM PC, XT or AT peripherals.

The PC87310 incorporates two full function UARTs, a floppy disk controller with analog data separator, one parallel port, control for one or two game ports, the address decoding for a hard disk controller, standard AT/XT address decoding for on-chip functions and a configuration register.

The PC87310 combines National's high-performance DP8473 floppy disk controller and industry standard UARTs. The Super I/O's floppy disk controller is software compatible with NEC's uPD765A, but offers many advanced features including a high-performance analog data separator unit.

For further details circle reader information service number 282 or contact National Semiconductor Australia, Business Park Drive, Monash Business Park, Nottinghill 3168, phone (03) 558 9999.

Vintage Radio



by PETER LANKSHEAR

The ancestors of today's batteries

Radio technology has always been very dependent on batteries. The history of batteries goes back 200 years, twice that of radio itself. During this long period, some very interesting ways of producing an electric current have evolved.

There is a common belief that the first practical battery was invented by Georges Leclanche in 1868, but in fact Leclanche's battery was a relative latecomer in a long line of developments – some successful, some bizarre, others dangerous, but most now forgotten.

The history of the battery actually starts in 1790, when Luigi Galvani of Bologna was experimenting with muscles from frog's legs. The story goes that he hung them on copper hooks, suspended from an iron railing. When the legs touched the iron, their muscles twitched from the stimulus of the electric current produced by contact with the dissimilar metals.

Another Italian, Alessandro Volta investigated the phenomenon further and in 1793, created the first battery – his 'Crown of Cups'. A row of glass cells filled with salt water was fitted with alternating series-connected copper and zinc plates. He discovered that the degree of muscle stimulus was proportional to the number of cells.

In 1800 Volta produced his 'Pile', a much more compact arrangement. Paired discs of copper and zinc were alternated with cardboard discs moistened with acidulated water. Initially, like the crown of cups, the pile used containers of dilute acid as terminals. It is worth noting that physically Volta's pile was identical to today's standard layer-built 9.0 volt carbon-zinc batteries – a space saving method of construction introduced to radio batteries about 60 years ago.

Polarisation problem

Volta's battery had made possible research into 'current electricity' (as opposed to 'static electricity'), but it had a major weakness. Under load, hydrogen bubbles built up on the copper electrode until the current was cut off. Operation could be restored by either removing the bubbles physically or resting the battery, but these remedies were both inconvenient.

The 19th century was the age of individual rather than corporate research, and experimenters were soon at work improving on Volta's pile. Various electrolytes and electrode materials were tried. Zinc was found to be the most satisfactory negative electrode and its use was universal. As acids will attack commercial grade zinc, in some instances the negative electrode was removed when the battery was idle, or it was coated with mercury as this was found to minimise wastage. Positive electrodes could be made from copper, silver, platinum or carbon and did not deteriorate.

One of the earliest developments was Wollaston's battery, an adaptation of the Crown of Cups using jars filled with dilute sulphuric acid. The electrodes were made as large as possible to lower the internal resistance and delay the onset of polarisation, and were mounted on a frame, so that they could be lifted out of the electrolyte when not in use.

Mechanical depolarisation was impractical, and experimenters concentrated on chemical methods which worked by persuading the hydrogen to combine with oxygen. This entailed surrounding the positive electrode with an oxidising material that reacted with hydrogen – but not at the expense of the normal operation of the electrolyte.

The first method was to use a liquid oxidiser with a porous container separating it from the acid electrolyte. In one popular variation, the *bichromate cell*, the electrolyte and depolariser were mixed together. A very important type used gravity to separate the liquids. Later, solid depolarisers surrounding the positive electrode were employed, as in the Leclanche and Edison cells.

Grove's cell

In 1839, Sir William Grove introduced a cell that performed excellently, but was expensive and produced a poisonous gas. Grove's cell consisted of a glass jar containing dilute sulphuric acid and a semicircular amalgamated zinc electrode, surrounding a porous earthenware pot. Inside the pot was a sheet platinum positive electrode and nitric acid. Hydrogen from the zinc and sulphuric acid reaction migrated through the walls of the porous pot to be oxidised by the nitric acid, producing water and nitric oxide fumes.

Platinum is not exactly cheap, and the German chemist Bunsen substituted a carbon positive electrode. Both the Grove and Bunsen cells were rated at 1.93 volts and the internal resistance of the 'quart' size (about 1 litre) was only 0.15 ohms, comparable to a small lead acid accumulator. These cells had ideal characteristics for experiments and were used well into the 20th century for laboratories and class room demonstrations.

Edison used a Bunsen battery in his development of the electric lamp. However, nitric acid is a dangerous material, and nitric oxide fumes require ventilating. Furthermore, when finished with, the cells had to be dismantled, the nitric acid and any free mercury bottled, and the electrodes and pots washed!

The Fuller cell substituted a mixture of sulphuric and chromic acids for the nitric acid of the Bunsen cell, to produce a more docile but still very useful source of current. It had the further advantage that it did not require dismantling.

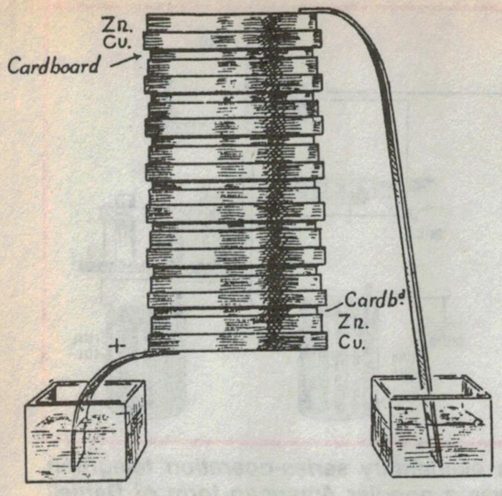


Fig.1: Volta's 'Pile', first made in 1800. Zinc/copper pairs of discs were alternated with cardboard discs moistened with dilute acid.

Bichromate cell

It was found that Fuller's cell could be simplified by eliminating the porous pot and separate sulphuric acid solution. By immersing carbon and zinc electrodes directly in a mixture of dilute sulphuric acid and either chromic acid or potassium bichromate, results were comparable to those from a Bunsen cell. The only precaution to be observed was that the zinc electrode had to be removed from the liquid 'electrolyte' when the cell was not in use.

Known generally as the *Bichromate* battery, in its original form each cell consisted of a shapely flask with a long wide neck supporting the electrodes. A rod enabled the position of the zinc to be adjusted to give some degree of current control, or for its complete removal from the electrolyte.

The Bichromate battery was used in early radio experiments. Producing about 2 volts per cell, and capable of supplying several amps, it was an inexpensive and reliable source of power for spark coils used for transmission. Other applications were for powering small electric motors and electroplating.

Apart from its aesthetic appeal, there was no particular merit in the fancy bottle and satisfactory home made versions were more mundane. Harmsworth's *1923 Radio Encyclopedia* gives detailed instructions for making a three-cell Bichromate battery in jam jars.

The electrolyte in a freshly charged cell was a most attractive orange colour, and I well remember as a youth making a Bichromate cell to provide the 2-volt filament power for a radio. It was most successful until an accident tipped the electrolyte down the wall. Somehow the orange-stained wallpaper was not so appealing to my parents!

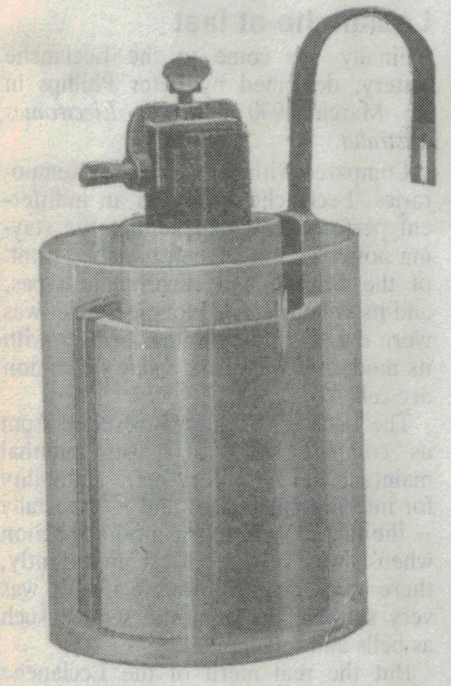


Fig.2: Bunsen's was a powerful but noxious cell. The carbon electrode inside the central unglazed earthenware pot was surrounded by strong nitric acid.

Daniell's cell

We now go back to 1836 and Professor Daniell of King's College, London. In that year he invented the principle of electroplating – and, at the same time, what was to be commercially the most important primary battery of all, until the close of the 19th century.

Daniell's was unique among the 19th century cells in that the chemical makeup of the electrolytes did not change during operation, and provided that the consumables were replaced and liquid volumes adjusted, output was maintained indefinitely. Furthermore, as no free hydrogen was involved in the reaction, it never polarised. It also used inexpensive materials. Why then, if this was such a paragon of cells, were other types bothered with?

Nothing is perfect, and the Daniell cell had limitations. Even in large sizes it had a high internal resistance, something like 50 times that of a bichromate cell of the same size, severely limiting its current capability. The voltage was only a fraction over 1.0 volt and if it was not kept working, the electrolytes would diffuse. However, as we shall see, in its chief application, these were not significant problems.

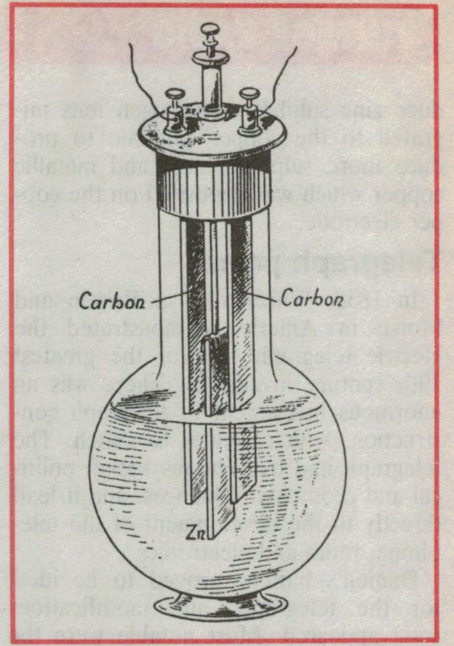


Fig.3: Grenet's Flask or Bottle Bichromate Cell. When idle, the zinc was withdrawn from the solution by means of the rod.

In its original form, Daniell's cell consisted of a copper jar that was also the positive electrode, containing a saturated solution of copper sulphate – the 'bluestone' used in garden sprays. Inside a porous central container was the zinc negative electrode and a dilute sulphuric acid, zinc sulphate or magnesium sulphate solution. During operation, this solution reacted with the zinc to pro-

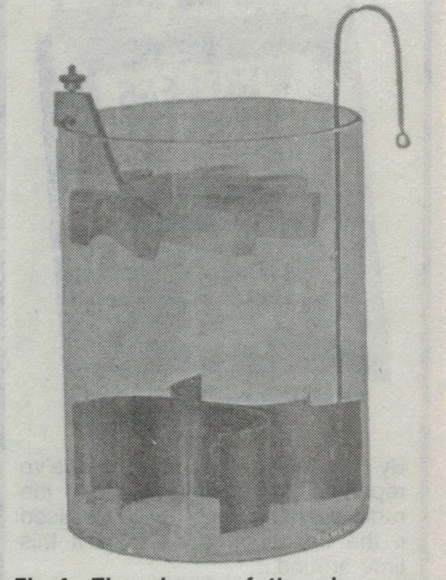


Fig.4: The shape of the zinc upper electrode suggested the name of the 'Crowfoot' Daniell gravity cell. It used saturated solutions of copper sulphate and zinc sulphate of different specific gravities.

duce zinc sulphate. Hydrogen ions migrated to the copper sulphate to produce more sulphuric acid and metallic copper which was deposited on the copper electrode.

Telegraph power

In 1838, Wheatstone in Britain and Morse in America demonstrated the electric telegraph, one of the greatest 19th century inventions. There was an enormous investment in telegraph construction, with revenues to match. The telegraph had tremendous social, political and economic influences, and it lead directly to the development of the telephone, radio and electronics.

Daniell's battery proved to be ideal for the telegraph, and modifications soon appeared. Most notable were the 'gravity' batteries. A solution of zinc sulphate will float on a copper sulphate solution. By putting the copper electrode and copper sulphate at the bottom of the jar, and suspending the zinc from the top, it was possible to eliminate the porous pot. The best known version was the *crowfoot*, named from the shape of the zinc electrode.

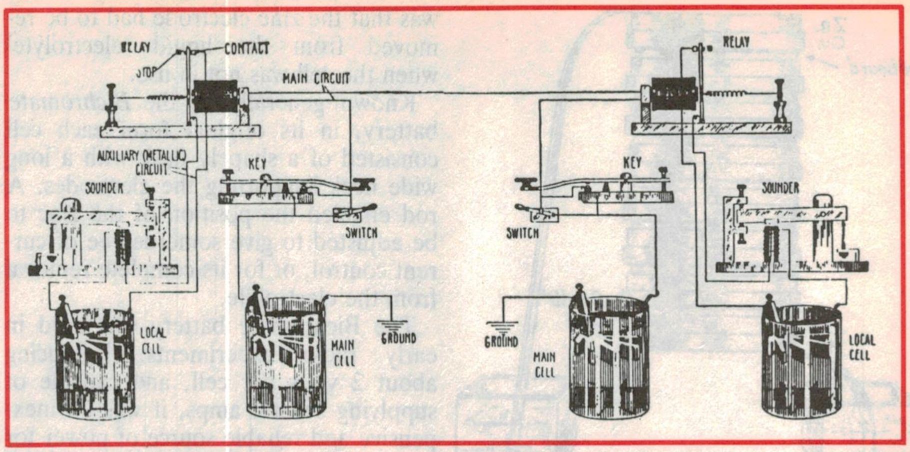


Fig.5: This 19th century sketch of an elementary series-operation telegraph illustrates that the Crowfoot Gravity was a popular American form of Daniell battery. In practice the local cells would have been the larger.

Unlike many other types, it was possible to tell at a glance the condition of a Daniell gravity battery and it could be maintained during operation. This entailed adding copper sulphate crystals, drawing off excess zinc sulphate solution and topping up with water – and from time to time, renewing the zinc electrodes.

By 1875, there was a worldwide network of electric telegraphs. The total number of cells powering them must have been astronomic. Some interesting statistics about one circuit come from Frank Clune's most readable book *Overland Telegraph*, describing the epic South Australian enterprise connecting Port Augusta with Darwin, the Australian terminal of the undersea cable to Asia and Europe.

Completed in 1872, the 1800 miles of 8-gauge iron wire was split into 11 sections with 10 intermediate stations, all connected in series. Each station had 120 'Meidinger' gravity Daniell line cells. Including terminals, there would have been 1,440 line cells producing a total of 1.5kV, and several dozen larger local instrument cells.

Daniell's batteries were not very suitable for domestic radios. Apart from the need for a continuous load, there was the problem of their size. Even the 'small' line cells had a good half gallon capacity! One unlikely domestic use was found in accumulator charging. Three Daniell cells could effectively 'float charge' a lead-acid cell used for intermittent lighting service.

Edison's battery

The last major development in 19th century primary batteries came from Thomas Edison, whose 'Improved Phonograph' of 1888 used an electric motor. Something more docile than Bunsen or bichromate cells were necessary for Victorian living rooms. Like Edison's better known secondary battery, it used a caustic potash solution for an electrolyte.

With an EMF of 0.75 volt per cell, Edison's battery used a depolariser of copper oxide. It was a low maintenance, low internal resistance battery with a high ampere-hour rating. A cell 175mm (7″) in diameter and 450mm (18″) high had a rating of 600Ah. The Edison was primarily an industrial battery used for telephone exchanges, fire alarms and railway signalling – applications now left to secondary batteries.

Leclanche at last

Finally, we come to the Leclanche battery, described by Peter Phillips in the March 1990 issue of *Electronics Australia*.

Compared with many of its contemporaries, Leclanche's cell was an indifferent performer. It had neither the staying power of the Daniell nor the 'grunt' of the Bunsen and Bichromate types, and its voltage sagged long before it was worn out – a problem that persists with its modern descendant, today's common dry cell.

The Leclanche's success resulted from its compact size, low cost, minimal maintenance requirements, suitability for intermittent service and – especially – the fact that there was no local action when it was 'resting'. Most importantly, there were no dangerous acids. It was very suitable for domestic service such as bells and telephones.

But the real merit of the Leclanche cell was that it was the parent of the zinc-carbon dry cell, without which portable battery power and the development of radio would have been very different.

PROGRAMMABLE CONTROL

Programmable control from your IBM-PC or compatible? Imagine being able to write and test logic control programs as easily as switching on a light bulb. Procon Technology has done just that with its PLC version 2.0 software. This program provides a relay ladder logic style of programming – shown above – that's easy to learn and easy to understand. What's more, it's the style of language used in multitudes of industrial controllers worldwide!

Together with our I/O board, this software turns your PC at home or in the office, school or laboratory into a powerful, yet flexible, programmable controller. Your computer becomes the centre of the control system – it monitors the inputs, scans and solves logic and performs other special functions to determine and set the output conditions.

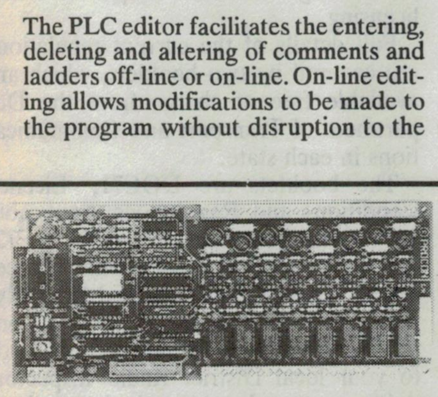
The PLC editor facilitates the entering, deleting and altering of comments and ladders off-line or on-line. On-line editing allows modifications to be made to the program without disruption to the control operations. E.g. You could adjust a time delay, correct a logic error or add more functions whilst the program continues to run — uninterrupted.

Unlike other programming languages, PLC version 2.0 also provides real-time indication of logic conditions continuously on the screen — again with no interruption to program execution. Each closed contact or activated output is highlighted on the screen and each timer's remaining duration is displayed. Monitoring and debugging control programs couldn't be easier!

Once a program has been debugged, it can then be loaded for execution in background whilst the computer is used for other things (such as word-processing or spreadsheets).

With additional I/O boards, numerous PLC application programs may run in the background providing an economical means of controlling many different items of equipment.

Applications include: Home or business automation and security systems, model control, laboratory automation and educational and training needs.



The NR-12VAC I/O board is mounted externally (up to 30 metres from the computer) and provides 8 isolated 12 Volt AC or DC inputs and 8 independent relay outputs. LED indication is provided on all inputs and outputs and all connections are via screw terminals. The system is capable of expanding to 240 I/O from one PA-BUS card inserted into a single card slot in the computer.

Other I/O options are available, including an industrial version. The I/O boards may also be controlled from other high-level languages.

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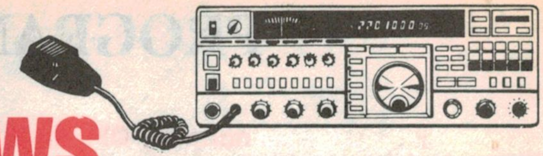

New 10GHz record for South Aust.

The WIA journal *Amateur Radio* reports that a new record has been set in South Australia for a contact on the 10GHz band, by Nick Tebneff VK5NT and Des Clift VK5ZO. The contact was from Illawarra Hill to the summit of Mount Lofty, a distance of 147.1km.

A Gunnplexer system was used at both ends, with operation on 10250MHz and 10280MHz respectively to give an IF of 30MHz. The antennas were 40cm metallised fibreglass dishes, with tapered-waveguide dipole-reflector feeds. One unit was fitted with AFC.

Signals were well over S9 both ways, with the dishes, so Nick and Des experimented with lower gain configurations. The link was still maintained with VK5NT using a 12dB horn alone, and VK5ZO using only the open end of his waveguide.

Congratulations to both Nick and Des for their achievement.

Spectrum plan changes proposed

WIA general manager and secretary Bill Roper VK3ARZ, writing in *Amateur Radio*, notes that DoTC recently forwarded a new draft Australian Spectrum Plan to the WIA for comment. Among the changes proposed were the allocation of Fixed and Mobile services to the 420-450MHz band, as co-secondary services along with the Amateur Service.

Needless to say the WIA has objected to this proposal, particularly in view of the recent withdrawal of the 576MHz band and the fact that the 420-450MHz band is the lowest on which amateur television transmissions can be made. The band is also used for propagation experiments using very weak signals, such as moonbounce contacts.

The WIA has also made other proposals to DoTC concerning the draft Spectrum Plan, including (a) a request for sub-bands within the bands from 420MHz to 10.45GHz to be allocated to amateurs on a Primary User basis; (b) a request for amateurs to be given access to the frequencies from 10.150-10.200MHz on a non-interference basis; and (c) a request for frequencies from 3700-3800kHz to be made available to the Amateur Service, in line with the Region 1 allocation for the 80m band.

Incidentally in making such proposals to DoTC, the WIA is essentially acting in the interests of all Australian amateurs, not just those who are its members. Any privileges gained as a result of its representations are always available to non-members, as well as members. However representing the interests of Australian amateurs in both national and international decision-making arenas is costly, and funded directly by WIA members. It's therefore a good idea for as many hams as possible to lend both their moral and financial support to the WIA, by joining up.

For information on joining, contact the Federal Office at PO Box 300, Caulfield South 3162, or phone (03) 528 5962.

Booklets on current regulations

All active amateurs need a reference to the current regulations applying to the Amateur Radio Service, in order to ensure that they continue to meet them (important, as they change from time to time). Prospective amateurs should also have such a reference, as knowledge of current regulations is a requirement for licensing.

Full details of the current regulations are covered by two booklets, which are available free of charge from the Department of Transport and Communications in each state.

The booklets are DOC71, 'Licence Conditions and Regulations Applicable to the Amateur Service', and DOC72, 'Amateur Service – Operating Procedures'. They can be obtained by applying to your State Manager, Department of Transport and Communications, or to your local District Radio Inspector. Addresses are in your telephone directory.

A third booklet in the same series is due out shortly, with information specifically for prospective amateurs.

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Information centre

Conducted by Peter Phillips

Wrong! Wrong! Wrong!

When you front a technical column, you expose yourself to the scrutiny of your peers. This month I come under fire for a simple circuit published in August, right a few other wrongs, steer a 12 year old away from danger and ask a few questions along the way.

A fact of human nature is that people generally only write in when they pick up a mistake, or if they disagree with the content of an article. Fair enough too – a whole series of letters saying nice things is probably rather boring, anyway! Over the years, I have come in for my share of criticism, and I still have on file letters that contest my honesty, my technical skills and even my right to remain with a particular magazine.

My thick skin and grovelling apologies (if I'm *really* wrong!) usually see me through these dramas, which fortunately don't occur all that often. OK, stop counting! But another interesting side benefit is that when a mistake occurs, we have a minor contest. A contest of right and wrong, in which someone loses. And that makes interesting reading, often resulting in a technical discussion that otherwise would have no reason to be presented.

The following topic is a classic example of how a mistake can occur, although I would have preferred one reader who phoned in to be a little more understanding. We do try, we are aware of our responsibility to readers, and we promise to be more careful next time and...

That VU meter

In the August edition, I presented a circuit for a VU meter that I stated could be added to the output of a mixer. This circuit was in response to a reader enquiry, and the reader has since informed me that the circuit doesn't work. Another reader has also drawn my attention to the circuit, stating that it couldn't possibly operate, and would simply show a zero reading. He was somewhat irate and also suggested that I *hadn't* tested the circuit. Fighting words...

So why did I state that I actually built and tested the circuit, when in practice it doesn't work? Am I being dishonest, and have readers found me out? Should I take up chicken sexing instead and leave this column to someone with more integrity? No! Here's my story, which I hope salves my reputation as well as raising some interesting technical discussion.

The truth is I did test the circuit, and it *did* work. In fact, when I started receiving the threatening phone calls, I scrounged around and found the original cobbled-up circuit I had used for test purposes. Fortunately it was still intact, and apart from one teensy weensy detail, was identical to the circuit shown as Fig.1 on page 156 in the August edition. (Blast! I couldn't even claim a printing error). I connected it to a signal generator and sure enough, it worked perfectly.

But, as hindsight and further investigation now shows, it can't. The original circuit is shown in Fig.1, and if I had thought more deeply about it, I would have noticed the error. But when you are confronted with a working model and a deadline, who's to argue.

In fact, all that can happen in Fig.1 is that C1 will charge up, initially giving a deflection on the meter. Once C1 is charged, current will no longer flow, as there is *no discharge path for C1*!

So why did my circuit work? Well, the teensy weensy difference between Fig.1 and my test circuit was that I had accidentally wired C1 in back to front, without noticing. As a result, the leakage current through this capacitor was sufficient to allow C1 to discharge on the negative half cycles. When I corrected this mistake, practice and theory agreed.

The required modification is to add another diode, shown as D2 in Fig.2. Also, to improve the frequency response, I've increased the value of C1 to 47uF.

But is this the circuit of a VU meter? No, not really, it is simply a circuit that will give an indication of signal level.

These days, the term VU (volume unit) meter is loosely applied to almost any indicating gadget mounted on an audio whatsit. Those that know about VU meters know that such an instrument is quite complex and that a general purpose moving coil meter is not a VU meter. But because the term is now generally accepted as anything that indicates an audio level, I have used it here in the interests of simplicity. A better

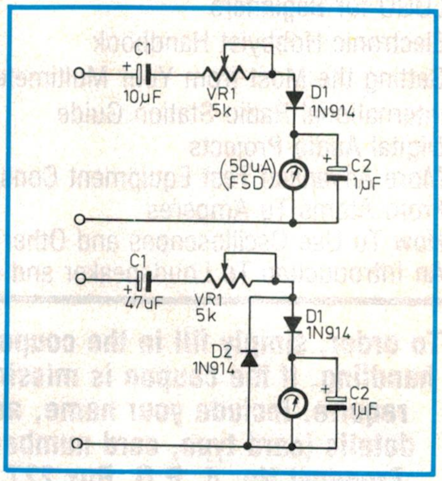


Fig.1 (top): The original circuit, which really doesn't work. But Fig.2 (below it) does – honest!

description of Fig.1 might have been a 'circuit that doesn't indicate signal level unless C1 is back to front' and Fig.2 as an 'audio level indicator'.

So, I did try the circuit and it did work. True, I made a minor wiring mistake; but without getting on a soap box, be assured folks, if nothing else, I try to be honest.

The next letter picks up a glaring error in a project published in the *ETI* section of the July edition of *EA*.

Headlight reminder

I wish to point out an error in the parts list for the Headlight and Parkers Alarm project described in page 2 and onwards in the July issue of the ETI section. Resistor R2 is specified with a power rating that will ensure its quick and painful destruction.

A quick check of the circuit reveals that whenever the accessories switch is on, and C1 has reached full charge, there will be 12V (13.8V with the motor running) across the series combination of R1 and R2. Note that when the accessories switch is turned on, C1 will appear as a short circuit and R1 will be dissipating approximately 20W, although only for a short time.

Assuming 5% resistors are used and that each resistor value is at the lower end of the tolerance band, the worst case current will be 13.8/(9.5 + 95), giving approximately 132mA.

This gives a power dissipation through R2 of 1.66W! A more suitable power rating would be 5W instead of the 1/4W as recommended. R1 will be dissipating 166mW (around 1/6W) and therefore should also be changed to at least a 1/2W, even a 1W rating.

Alternatively, the use of a relay to switch the buzzer would avoid the power dissipation problem. A diode across the coil would be required to limit the back EMF at switch off. (G.H., Bundall Qld).

Like the VU meter circuit, the project referred to by G.H. is very simple and is even presented as being ideal for beginners. There is no contesting your mathematics G.H., and this error has been picked up by quite a few readers. I could now go on at length about our trust in the contributor of the article, about a heavy workload that prevents double checking and so on. But I won't!

All we can do in these circumstances is acknowledge the error, take any flack and hope it won't happen again. My belief is that the circuit wasn't tested, (mine was!), and that the developer fell into the trap of assuming that such a simple circuit *must work*. Such is the minefield called 'simple projects.'

A string of errors

It seems some contributors to this column just can't win. When T.C. of Glen Waverley sent in a relay circuit in response to another reader's enquiry, he mentioned that he had offered this circuit to *EA* many years ago, but it was never printed. I presented the circuit in June because it was such a neat solution to the problem, but gremlins saw to it that the diagram appeared in reverse.

The circuit was then printed right way round in August, but T.C. had already spotted the drawing error and had assumed it would be corrected before being reprinted. When this didn't happen, in mild desperation T.C. wrote again to advise me of the error. Sorry T.C., quite obviously the circuit as presented couldn't possibly work, and I hope readers weren't too confused.

The circuit diagram in question is the lower of the two relay circuits shown on page 159 (August 1990). Contact 2B is shown in the normally open position rather than the normally closed position. A definite case of wrong, wrong, wrong, and as T.C. heads his letter...'third time lucky!'

A legal tussle

The following letter raises a few interesting points and I would be glad to hear from readers who can offer a learned opinion on its content.

My parents purchased a colour TV set some 18 months ago, and soon after the warranty period of 12 months expired, the set started suffering intermittent red blurring. Eventually the fault went hard, leaving an overall green hue on the screen. The retailer's service department was called in, and the fault was diagnosed as being a short circuit between the red and blue cathodes of the picture tube.

The retailer refused to replace the tube for free, or to even offer a discount for a new one, as my parents hadn't paid a $300 fee to cover a two year service contract. Instead, the fault was 'fixed' by electrically blasting the short apart. However, a fee is being charged, and no guarantee has been offered to the longevity of the repair. Both parties are due to appear in court.

I am writing, not about the rights and wrongs of this case, but about the fault itself. How often have you heard of an 18 month old CRT developing a short? Do you think it is a manufacturing defect? And what is the average life of a TV picture tube? What is a reasonable life? And finally, how long do you think the repair will last and what are the likely effects this might have on the rest of the tube? (R.S., Lower Hutt NZ).

In my years as a TV serviceman, I encountered at various times a heater to cathode short, but never a short between two cathodes. However, I have not done a lot of servicing over the last 10 years, and maybe those readers currently working in the field would like to comment. Obviously the fault is *some kind* of manufacturing defect, but unfortunately it manifested itself outside the warranty period. Just how successful the court case will be is a matter for conjecture, but I can't help wonder at the philosophy of pressing for payment in these circumstances.

My feeling is that the repair will probably last and that no ill effects will occur, although I still cannot see how such a short occurred. But then, stranger things have happened. The normal life of a colour tube in a TV set is difficult to define, but 10 years is probably reasonable, given typical viewing habits. What do readers think?

Lotsa volts

I don't often get letters from younger readers, particularly like that of the following...

I am 12 years old and make simple circuits which are more conversation pieces than useful, such as electric shockers, things which 'spark', powerful electromagnets and more. Please answer my queries:

1. *How many volts does it take to spark a centimetre?*
2. *At 200V, what amperage would be safe to use as a shocker?*
3. *Is it unhealthy to get many electric shocks purposely?*
4. *Why, with DC and a step-up transformer do you only feel a shock when the circuit is disconnected?*
5. *Would the following circuit (of my own design) for a variable strobe light work and be safe?*
6. *What books could you recommend to explain magnetism and electromagnetic induction?*

PS: Print my name, but not my address. (G.K.)

Your anonymity is assured G.K., but your longevity may not be! I'm not including G.K.'s circuit, in case someone actually builds it. Basically it consists of a transistor with a xenon tube and trigger transformer all connected direct to

INFORMATION CENTRE

the mains. Don't do it, G.K. – it's lethal! Please play with something less dangerous, something that doesn't connect to the mains, at least.

Regarding the questions, it seems you have a fascination with high voltages. This is not bad in itself, as many other readers share this interest, but you must be careful. Very careful. For example, read what happened to Branco Justic in the article on the laser project, published in July.

Regarding the questions, I cannot give a specific value of a voltage to cross 1cm, but it will be several kilovolts. Note the kilo, as in 'kill'... However, there are relatively safe ways to produce a high voltage, so let's examine the safe aspect first, which answers question 2.

An electric shock is the result of current flowing through your body, and currents of less than 2mA are generally only felt as a tingle. If the current exceeds 8mA or so, muscle spasm sets in, and anything over 12mA will limit your ability to let go the conductor, particularly for a DC voltage. A current of 50mA, if passed through the heart will cause the effect of *ventricular fibrillation,* in which the heart twitches, but without effectively pumping blood. At 100mA or more, the heart will stop, and thereafter, you're definitely a dead man.

Naturally, the longer the shock occurs the worse your chances, and very short duration shocks are usually not lethal. However, such a shock may leave burns, and don't forget that many people injure themselves because of a muscular reaction causing them to fall or hit something. A shock delivered by a battery connected to a coil is generally fairly short and sharp, but don't assume it cannot kill!

The safest(!) method of producing a high voltage is using static electricity. Many schools will have a *Wilmshurst* machine, which is a device that generates very high voltages by friction between a rotating wheel and fixed brushes. A favourite demonstration is a Wilmshurst machine connected to various spark gaps, and quite spectacular displays can result. See your science teacher, G.K.; perhaps your school has one of these devices.

A coil produces a high voltage when the battery is disconnected because the magnetic field produced by the current flowing in the coil collapses when the battery is disconnected. When this happens, a voltage is produced by electromagnetic induction. For a description of how this happens, try the Basic Electronics series currently being published in *EA*. No prizes for guessing who's writing it, and the subject of magnetism and electromagnetic induction is treated in reasonable detail.

Regarding the effects of numerous electric shocks, I can only say that anything in quantity is bad for you, even jelly beans. Every time a shock occurs, some form of chemical reaction occurs inside your body, and I thoroughly recommend you to examine electricity in other ways. It's a fascinating hobby, but giving yourself electric shocks is not really a good way to explore the hobby.

Assuming we are both still around in 10 years or so, I would love to hear from you again G.K. – perhaps when you are heading a research team or graduating from university. I can see you are obviously interested in electricity, and your knowledge is quite amazing considering your age. But please take care!

What??

This month's question comes from Ron Steinfeld of Glen Waverley. Incidentally Ron also asks whether *EA* is intending to publish a TV/CRO adapter project. The answer is yes, and the prototype has been operating for some time now. It's my design, and I have to say it's gonna 'knock your socks off'. However, it will be a few months yet, as time is a bit of a problem.

Ron's question is, given that the voltage between point A and ground of Fig.3 is 100V DC (as measured with a DC voltmeter), determine the voltage

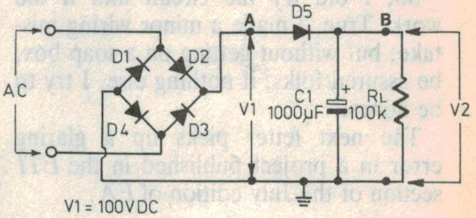


Fig.3: Knowing V1 is 100V DC, can you work out V2?

between point B and ground. Perhaps you might also like to calculate the RMS value of the AC input voltage. For the purposes of the question, assume no losses in the diodes or transformer and that the input is a 50Hz sinewave.

Answer to last month's What??

The answer to last month's What?? is V1 equals 144V. The solution is as follows:

1. V1 = 64I (...a) and V1 + 31 = 70(I + 0.25) (...b) from the circuit using Ohm's law.
2. Replacing V1 with 64I in (b) above, then rearranging the terms after multiplying the RHS of (b) gives 64I = 70I − 13.5. This solves to a current (I) of 2.25A. Putting this into (a) gives the answer of 144V for V1.

I told you it was simple!

NOTES & ERRATA

LOUDSPEAKER TECHNOLOGY (August 1990): The item on ETI page 32 describing Odyl Group's new C300 flush mounted ceiling/wall speaker should have given the unit's sensitivity as 92dB, not 90dB. Also the phone number given for Odyl Group was incorrect; it is in fact (03) 879 5111.

CRYSTAL FREQUENCY CALIBRATOR (March 1990): Some brands of 4011 device apparently have rather higher propagation delay than those tried in the prototype, preventing IC1a from oscillating at 10MHz with the published circuit values. Reducing the AC feedback resistor from 2.2k to 560 ohms will generally assist in achieving reliable oscillation at the correct frequency, although it may also be necessary to reduce the value of the phase shifting capacitor from its present 100pF value, with some 4011 devices. Note too that in many cases IC1, IC2 and IC3 will NOT operate correctly unless the supply voltage is at least 7.5 volts, because of the increase in propagation delay at lower voltages.

SERVICEMAN (August 1990): Due to an unfortunate 'gremlin', which was not detected until the magazine had been printed, a section of the text became transposed from its correct position. The section concerned is that in italics, which appeared on page 48 with its last four lines on page 49. This was in fact the second story from L.D., and should have appeared immediately after his first story – which ended some 14 lines from the start of page 47. We apologise for this problem.

420-450MHZ CONVERTER (June 1990): The 'gremlin' apparently was

around a while before we became aware of him, and rearranged the text for this project as well. Page 119 continues at the top of the second column on page 121, and the text from page 120 and the first column of page 121 should have appeared before the sentence commencing 'Now change the RF input' in the lower section of column two. Apologies for this error.

'BLUE STREAK' RISC COMPUTER CARD (ETI April, July, August 1990): The distribution of VLSI Technology devices in Australia has now passed to George Brown Group, which is currently only able to supply built-up evaluation boards sourced from the USA – at a rather higher price than the kit originally being offered by Energy Control International. However GBG has advised that it will consider locally sourcing a kit if there is sufficient reader interest. Readers interested in this possibility are advised to contact Mr Rob Roughton at George Brown Group in Sydney; phone (02) 638 1888, or fax (02) 638 1798.

PRO SERIES ONE POWERAMP (December 1989/January 1990): There have been a coupled of reported instances where the amp delivers small bursts of oscillations under difficult load conditions. It's quite easy to detect, since the overload/error LEDs will illuminate as the NFB loop tries to correct the output signal. The cure is quite simple; just remove the 330pF compensation capacitor (C9) from the underside of the PCB – C10 will still provide an appropriate load for the driver stage. When the amp is performing correctly, the overload LEDs should only illuminate at full power.

VIDEO FRAME GRABBER: FURTHER NOTES

In the August 1989 we published a Video Frame Grabber design by Keith Heavens, which attracted a great deal of interest. However there have also been a few problems. Some of these have been covered by Notes and Errata published in the November 1989 and June 1990 issues, but Sydney reader Mr Paul Turtle has very kindly advised of the following remaining bugs, and their remedies:

The following notes were compiled as I assembled the Frame Grabber. Please read them in conjunction with the original article of August 1989, as the figure and page numbers refer to that article:

1. The VSYNC line on Fig.4 page 86 is shown going from pin 8 of U16d. On the printed circuit board, however, the track goes from pin 9 of U16d instead. The other connections to pin 9 are correct on the PCB. This requires a track to be cut and a jumper wire put in. The modification can be carried out as follows. Please make reference to the PC board and the parts overlay diagram on page 85.

   Begin tracing the track on the top of the board that starts on the cathode of D6 (between U9 and U10). This track proceeds down and then to the left of the board. The track disappears at a feedthrough immediately below U8 and then reappears again by another feedthrough just below U7. The best place to cut the track is just to the left of this feedthrough, before the track curves down and disappears again under U16 (assuming the components are in place on the board). After going under U16 the track wrongly terminates on pin 9 instead of pin 8 as mentioned above. On the rear of the board, it is now an easy matter to place a short jumper wire onto pin 8 of U16 and, using the feedthrough below U7, join back onto the original track.
2. Transistors Q1 and Q2 are transposed on the circuit as shown in Fig.4 on page 86. As these are the same part number, the circuit will still work correctly as shown, although this may cause difficulty if the circuit needs to be traced in case of difficulty.
3. It appears that D2 and D3 are transposed on the board relative to Fig.3 page 86, although once again this will only provide problems if signal tracing is attempted. The correct orientation of these two diodes is as follows: Diode D2 on the parts overlay has its cathode (black band) to the left and diode D3 has its cathode up.
4. The orientation of the other diodes on the board is not marked and has to be determined by tracing the circuit. All diodes apart from D2 and D3 are mounted vertically. If you follow the parts overlay and install the body of the diode above the correct hole, then the cathode of the diode should be pointing up.
5. Capacitor C17 shown in Fig.3 page 86 should have its polarity reversed.
6. Capacitor C18 shown in Fig.3 page 86 does not exist on the board.
7. Take extreme care with the tantalum capacitors C5, C6, and C17, as these are connected across the negative voltage regulator and must have their positive lead to the GND line. Double check the board with a multimeter when placing these components, as a wrong orientation will probably result in the capacitor exploding.
8. The jumper settings for the port address of the board are set for addresses 6E2 and 6E3 with the connections as shown on the parts overlay. Note, however, that the program DEMO.EXE on the diskette uses the other address. Make sure you execute DEMO6E2.EXE instead, or change the jumpers to suit the other address.
9. Be extremely careful when inserting the components in the analog section at the upper right of the board. There are various holes in the PC board simply used as feedthroughs and it is possible to insert components in the wrong set of holes. If in doubt, check carefully with a multimeter. Of particular interest is the hole immediately adjacent to pin 13 of U12, which is not a feedthrough but should remain unused anyway.
10. When the board is inserted in a standard PC, the LM317 regulator U22 may touch a board fitted in an adjacent slot. The regulator may be bent over slightly to lessen any change of short circuits onto the other card. Because the metal tab of the LM317 is connected to one of its pins, allowing it to touch an adjacent board could short circuit and damage one or both of the boards.

WORKSTATION

EA'S COMPUTING SUPPLEMENT

Canon's new CLC 500 colour laser copier/printing system

SHARP'S NEW JX-100 COLOUR SCANNER • SMALL COMPUTERS IN ELECTRONICS • LATEST PRODUCTS

Computer hardware review:

Sharp's JX-100 'handy colour scanner'

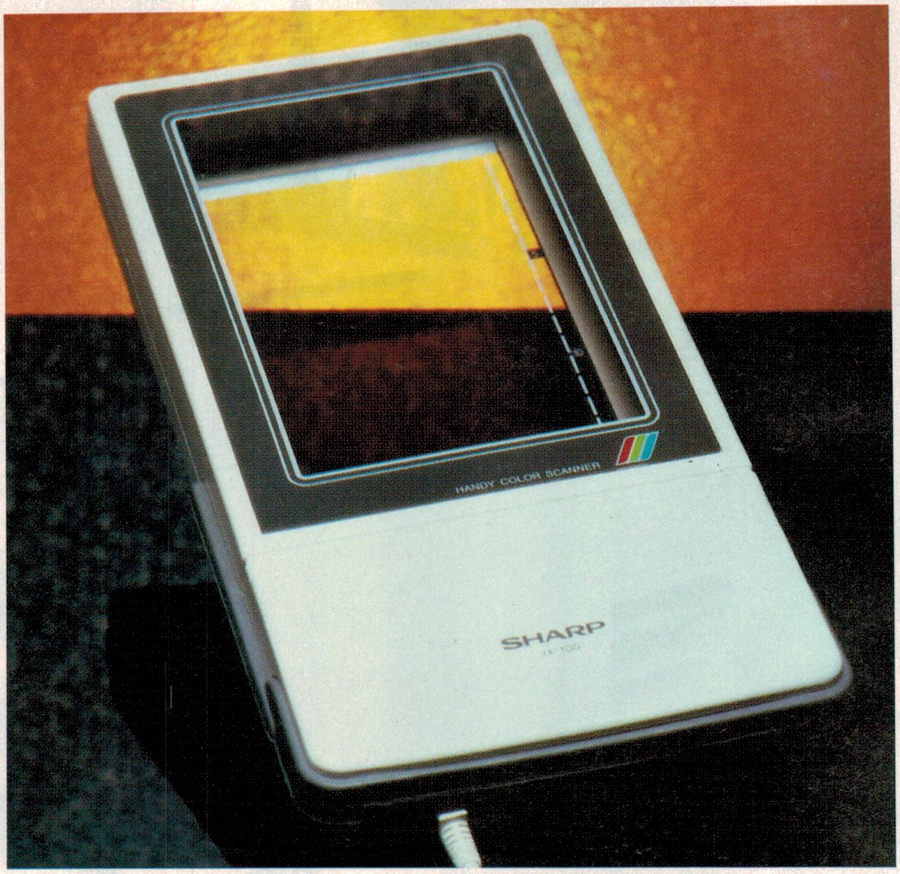
Sharp Corporation has released a new low-end addition to its range of colour graphics scanners. Described as the smallest colour image scanner in the world, the JX-100 can scan an A6-sized area and interfaces to Commodore Amiga, Apple Macintosh or IBM compatible computers. Jim Rowe has been trying one out...

First of all, I guess it's necessary to define what we mean by the word 'scanner'. We're not talking here about specialised radio receivers, able to hunt through the spectrum in search of stations, but a rather different device designed to scan optically graphic material in 'hard copy' form – photographs, drawings and so on – and effectively convert them into digitally coded electronic form. The resulting data file generally ends up on magnetic disk, for further processing.

This kind of scanner has been around for some years in the printing industry, in professional and very expensive form. But with the growth of personal computers and (especially) desktop publishing packages, there has been a parallel demand for cheaper and more accessible units. And in the last couple of years, these 'personal' scanners have begun to appear – initially in monochrome (black and white) form, but more recently with full colour capabilities.

The more 'up market' personal scanners have been of the *flat bed* type, generally with a horizontal glass surface on which the image to be scanned is placed face down – as with a photocopier. In fact the scanning mechanism is often almost identical with that in a small photocopier. A typical personal scanner of this type will accept images up to A4 size (297 x 210mm).

In the last couple of years much smaller hand-held scanners have appeared. These look a little like a small paint or burnishing roller enclosed in a housing, and are designed to be rolled over the surface of the image to be scanned. A friction roller or wheel couples the hand-driven movement to an internal scanning system.



Sharp's JX-100: compact and reliable 200dpi image scanning.

This type of scanner is admittedly much cheaper than the flat-bed type, but it's generally agreed that they deliver rather poorer results. Apart from anything else, it's surprisingly hard to roll them over the image smoothly, evenly and without skidding or skewing.

Enter Sharp, with its new JX-100 scanner. This is almost as small as one of the hand-held types, only 160 x 320 x 40mm, but with a built-in automatic scanning mechanism like the flat-bed type. It's designed to be simply placed on top of the image to be scanned, with a transparent window to allow you to position it as desired. The inbuilt scanning mechanism does the rest, under software control from the computer.

The big advantage of this approach is that unlike a hand-held scanner, the JX-100 can make three sequential scans of the desired image, in exact alignment – as necessary for colour scanning. Providing you don't bump or move it between scans, that is.

The effective scanning area of the JX-100 is nominally A6 sized, or 100 x 160mm. This is perhaps a little limited, but sufficient to scan a lot of typical photographs, logo's and similar items.

It scans this area by means of a relatively narrow sensor carriage, which moves along guide bars on either side. Inside the carriage housing appears to be a tiny fluorescent lamp, for even illumination, and a linear CCD sensor array. This is apparently a triple array, with built-in stripe filters to provide the filtering for colour scans. A small stepper motor system moves the carriage along the guide rails, smoothly and at a rate controlled by software. Very compact and elegant!

Rated nominal resolution of the JX-100 is 200dpi (dots per inch) and this is essentially the maximum resolution for grey-scale art, although for two-gradation 'line' graphics it can deliver 400dpi. The working resolution is selectable via the control software, and naturally determines the actual scanning time; the more resolution you want, the longer it takes.

Scan time varies between about 40 seconds for a monochrome 'line' scan and 9 minutes for a colour half-tone scan, for 200dpi scanning of the full 100 x 160mm area. To these figures you have to be add a sensor 'warmup' time, which is about 20 seconds for a line scan and 50 seconds for a half-tone scan. However the software allows you to speed things up for smaller items, by reducing the area scanned.

Power for the JX-100 comes from a small 12V DC plug-pack supply; it consumes about 8.4 watts. The signal interface to the computer is a serial RS232C line, ending in a DB-9 plug-pin. Data can be transferred at any rate between 9600bps and 115.2kbps, selectable by software command, with the 9600bps rate a power-up default. In contrast the accompanying software seems to be designed to operate only at either 56kbps (the preferred and default figure) or 9600bps.

The actual software that comes with the JX-100 is called *ColorLab 100*, and in the IBM-PC and compatibles version it's supported by Microsoft's *Windows*. In fact *Windows* and a Microsoft mouse come as part of the package, with this version. The review sample came with *Windows 2.0*, but I suspect by the time you read this, version 3.0 will have taken its place.

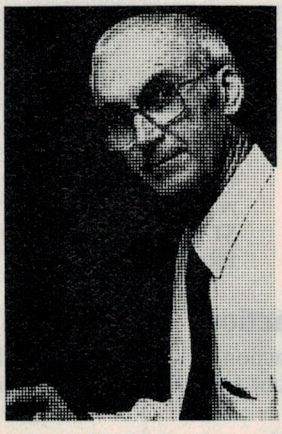
Incidentally *ColorLab 100* itself requires at least a VGA graphics card or better; it doesn't seem to run on EGA or CGA.

As with other *Windows* applications software, *ColorLab 100* has a system of easy-to-use pull down menus. Here they let you set up the JX-100 communications interface, nominate the desired scanning resolution and set up the precise scanning area. You can also select colour, mono grey-scale or line-art scanning, the grey-scale threshold for two-level conversion, and also enable gamma correction if desired.

The program also has a 'Prescan' function, which allows you to do a quick monochrome line scan before the main scan – to check scanner position, scanned area size and so on. Then when everything is set up to your liking, you can get it to perform the main scan.

For colour scanning *ColorLab 100* incorporates a proprietary hue reduction process known as *Optimised Palette Reduction* (OPR). This analyses the incoming 24-bit data, with its potential 16.8 million different colours (8 bits each for red, green and blue), and reduces them to a maximum of 256 – while still maintaining the colour balance and image resolution. The reduced image is used for screen display and is available for other use, along with the 'raw' 24-bit scan image data.

After scanning the image, it is stored on disk by *ColorLab 100* in a temporary file, using its own CPI (ColorLab Processed Image) format. However the program can then be used to process this file, and convert it into a variety of different image file formats as desired – to feed into other packages. Supported file formats include TIFF (tagged image file format), EPS (encapsulated PostScript), TGA (TrueVision/Targa format) and PCX (Publisher's Paintbrush). All of these formats have resolutions which are independant of the screen resolution.



A sample JX-100 scan of the 'Forum' heading pic, processed via Ventura Publisher before printing with the TI microLaser.

In short, then, the combination of JX-100 scanner and *ColorLab 100* software package is quite powerful and flexible.

Trying it out

We tried out the review package with the only PC-AT compatible in the *EA* office fitted with a VGA graphics adaptor and matching monitor. (Just for the record we also tried installing it on an EGA machine; *Windows 2.0* would install and run happily, of course, but *ColorLab 100* simply crashed...)

On the VGA machine, installing both the JX-100 hardware and the *ColorLab 100* software turned out to be quite straightforward. Once we fired it up, there *was* a short hiatus until we worked out whether it was the scanner or mouse that was plugged into the COM1: serial port, and then by default the one plugged into COM2:. But once this was sorted out and *ColorLab 100* appropriately set up, it was 'all systems go'. Communications with the scanner seemed quite reliable at the 56kbps rate, so we didn't bother with the alternative 9600bps.

We tried scanning a variety of different images, both colour and monochrome, and the results were very good. We also tried porting the images over into *Ventura Publisher*, using the TIFF format, so that we could print them out on the 300dpi TI microLaser. A sample of the kind of output this produced is reproduced here, and hopefully it won't have suffered too much in the printing process (Sorry it's yet another pic of yours truly).

Not surprisingly the results fell a little short of those achievable with our printer's usual scanners, because of both the JX-100's maximum half-tone resolution of 200dpi and the 300dpi limit for the microLaser. But they were quite respectable none the less, and we *are* after all talking about a scanner that costs something like 1/50th the price of those available for comparison!

Our impression is that if you're after a reasonably priced scanner for use with a personal publishing system, and you don't need to scan any images larger than 100 x 160mm, the Sharp JX-100 would be well worth considering. It's

Continued on page 156

In this final part of his five-part series, Elmo Jantz looks at basic arithmetic operations and indexed addressing modes.

THE BASICS OF MICROPROCESSORS

The 6502 has facilities incorporated into its design to enable it to carry out basic arithmetic operations such as addition and subtraction. Multiplication and division are achieved by successive addition or subtraction, and require the generation of a suitable program.

In this article, we will confine ourselves to the addition and subtraction operations.

Addition

The table shown below indicates how two single bit binary numbers A and B are added. S represents their sum and C the carry.

A	B	S	C
1	1	0	1
0	1	1	0
1	0	1	0
0	0	0	0

The 6502 deals with 8 bit numbers. Any carry generated from a previous addition is added onto the least significant bit. If the result of the addition exceeds $FF = 255_{10}, the carry flag in the P-register is set; otherwise it is cleared.

Let us examine the procedure by adding the two hex numbers $AF and $B3. We assume that initially there is no carry left over from a previous addition:

```
$AF  = 1010 1111
$B3  = 1011 0011
               0   (carry)
       0110 0010   C = 1
```

The sum equals $62 with the new value of the carry being equal to 1 since a 1 is carried out from bit 7. Note that the sum exceeds $FF.

The op-code chart shows the 'add with carry' instruction as being ADC, which is symbolically represented by A + M + C → A. This means that the number in a memory location M is added to the number in the accumulator. The carry is also included in the procedure and is added onto the least significant bit. The sum goes into the accumulator. If you examine the last column in the op-code chart you will see that the N, V, Z and C flags are modified by the ADC instruction.

Let us write a program segment to better understand the ADC operation.

Suppose we load the accumulator with one of the numbers we had in the above example. We can then add the second number to it in the immediate mode and store the sum in some memory location. The program segment should look like this:

```
LOC   EQU   $03D0
      CLC
      LDA   #$AF
      ADC   #$B3
      STA   LOC
      BRK
```

Run the program and check out the contents of $03D0. It should be $62. There is no direct method of reading the carry. A few lines of program can however be added to overcome the problem as follows:

```
LOC1  EQU   $03D0
LOC2  EQU   $03D1
      CLC
      LDA   #$AF
      ADC   #$B3
      STA   LOC1
      LDA   #$00
      ADC   #$00
      STA   LOC2
      BRK
```

Subtraction

Subtraction in binary requires the use of the four following rules to be remembered:

Minuend	1	1	0	0	
Subtrahend	1	0	0	1	
Difference	0	1	0	1	(and a borrow)

The 6502 deals in 8 bit numbers, but the same rules can still be applied. The numbers involved are called the Minuend and Subtrahend as shown above.

Subtraction requires a borrow and the complement of the carry is used for this – i.e., C-bar is the borrow. If a subtraction requires a borrow, then C-bar = 1, i.e., C = 0 or the carry is cleared. On the other hand, if no borrow is required, C = 1 or the carry is set.

The 6502 performs subtraction with the SBC or 'Subtract with Carry' instruction. Identify this instruction on the op-code chart. It is shown symbolically as A - M - C-bar →A. This indicates that the number in a memory location M is subtracted from the number in the accumulator. The complement of the carry is also subtracted and the final result placed in the accumulator.

A program segment to subtract $B3 from $AF is as shown below. We assume that no borrows are left over from previous subtractions. This means that the carry flag should be set before the subtraction is carried out.

```
SEC
LDA   #$AF
SBC   #$B3
STA   $03D0
BRK
```

Run the above program on your computer and verify that it works. You should have $FC in location $03D0. A few extra program lines could be added, similar to those we used in the addition program to read the carry.

An instruction very closely linked to the SBC is the 'compare' instruction – CMP. This is available in two other forms, CPX and CPY. They are used to verify whether a number is greater than, equal to or less than a second number:

1. If the number in the accumulator, X or Y register is greater than the operand, i.e., the other number, the carry is set and the Z flag is cleared.
2. If the number in the register is equal to the operand, the result of the subtraction will be zero, and the Z flag

will be set. The C flag is also set.

3. If the number in the register is smaller than the operand, the Z flag is cleared. In this case a borrow is required, i.e., C-bar = 1 and the carry is cleared.

Decimal Mode arithmetic, that is, arithmetic involving the numbers 0 to 9, merely requires the SED – 'Set Decimal' instruction to be included in the above programs. A program segment to add in decimal mode the numbers 92 and 25 is as follows:

```
SED
CLC
LDA    #92
ADC    #25
STA           $03D0
BRK
```

The result should be 17, and the carry should be set.

Finally, the decimal mode can be cleared with a CLD instruction.

Indexed addressing

One of the most useful addressing modes available in the 6502 is called Indexed Addressing. This is comprised of the four following sub-groups.

Absolute Indexed Addressing
Zero Page Indexed Addressing
Indirect Indexed Addressing
Indexed Indirect Addressing

Indexed addressing is ideal for dealing with large amounts of data such as tables and arrays. It facilitates the setting up of programs for multibyte arithmetic and code conversion. The op-code chart lists indexed addressing under the following headings: ABS, X; ABS, Y; Z – PAGE, X; Z – PAGE, Y; (IND), Y and (IND, X).

Let us examine the absolute indexed addressing modes ABS, X and ABS, Y. The X and Y indicate that the numbers in the X and Y registers are to be used as indices, which are added onto a base address.

Consider the following program segment:

```
LOC   EQU    $03D0
      LDX    #$31
      STA    LOC, X
       "      "
       "      "
       "      "
```

The base address is $0300 and the X-register contains $31. Line 3 indicates that the accumulator contents are to be stored at memory location $03D0, indexed with $31. The required address is found by adding $31 to $03D0, to give $0401. The contents of the accumulator are stored at this memory location. The Y-register could also be used in the above example to provide the required index.

Let us examine a program to carry out multibyte addition. In this type of arithmetic the numbers involved are two, three or more bytes wide. Assume that two numbers are to be added and that each is three bytes wide. We will call the numbers ADDEND 1 and ADDEND 2 respectively:

Let: ADDEND 1 = $02 $0F $34 and
ADDEND 2 = $01 $0E $08.

Assume ADDEND 1 is stored in memory locations $03D0, $03D1 and $03D2 as follows:

```
03D0 : 02
03D1 : 0F
03D2 : 34
```

Similarly, let ADDEND 2 be stored in locations $03D4 through $03D6 as follows:

```
03D4 : 01
03D5 : 0E
03D6 : 08
```

The problem can be written out in the normal manner as follows:

```
ADDEND 1     02    0F 34
ADDEND 2     01    0E 08
SUM
```

The sum is to be stored in locations $03D8 through $03DA, with the most significant byte going into $03D8.

The program should be similar to the following:

```
     CLC              ; Clear Carry
     LDX #$03         ; Load X-register with
                        the number of bytes
LOOP LDA $03CF, X ;     Load the accumula-
                        tor with the byte in
                        $03D2
     ADC $03D3, X;      Add with carry the
                        byte in $03D6
     STA $03D7, X ;     Store result of addi-
                        tion in $03DA
     DEX              ; Decrement the
                        value in the
                        X-register
     BNE LOOP         ; Repeat until all
                        bytes are added
     BRK              ; End
```

In line 1 the carry is cleared, in case it was set from a previous addition. Line 2 sets the X-register to the number of bytes to be added from each number – three in this case. Next, the accumulator is loaded with the byte in $03D2 – Line 3. Indexed addressing is used for this. $03CF + $03 = $03D2, the address where the third byte of ADDEND 1, namely $34 is stored.

In line 4, the third byte of ADDEND 2 is added to the number in the accumulator using indexed addressing. $03D3 + $03 = $03D6, the address of the third byte of ADDEND 2. The result of the addition of each pair of bytes is stored in locations whose addresses are calculated using indexed addressing – line 5.

The X-register is then decremented and the next pair of bytes are added – line 6. Line 7 indicates that the procedure is to be repeated until all three pairs of bytes are added. The loop is executed as long as the X-register is not equal to zero. In fact when X = 1, the last pair of bytes are added. When X = 0, the program drops out of the loop and ends.

Addition proceeds from right to left as in normal decimal arithmetic. Run the program on your computer and check out memory locations $03D8 through $03DA for the result of the addition. They should have the following information:

```
03D8 : 03
03D9 : 1D
03DA : 34
```

Zero page indexed addressing is very similar to absolute indexed addressing except that the memory locations accessed will always be in page zero. The op-code chart shows two zero page indexed addressing modes: Z-page, X and Z-page, Y. The high order byte of the address accessed is understood to be $00.

Let the number in the X-register be $03 and the base address be $05. A program segment to store the contents of the accumulator in address location $08 = $05 + $03 will be as follows:

```
LDA    #$AA
LDX    #$05
STA    $03, X
BRK
```

If a carry is generated in the addition, it is ignored. For example, if the base address is $F2 and the X-register holds $30, the result of the addition is $F2 + $30 = $22 with the carry = 1, but this is ignored.

Indirect Indexed Addressing, also called Post Indexed Addressing, is very similar to Indexed Addressing. The opcode chart shows this addressing mode as (IND), Y. No X version is available. Post indexed addressing uses locations in page zero to determine the address of the operand. Consider the following program segment.

```
LOC EQU $E0
    LDY #$33
    LDA (LOC), Y
     "     "
     "     "
     "     "
```

Continued on page 161

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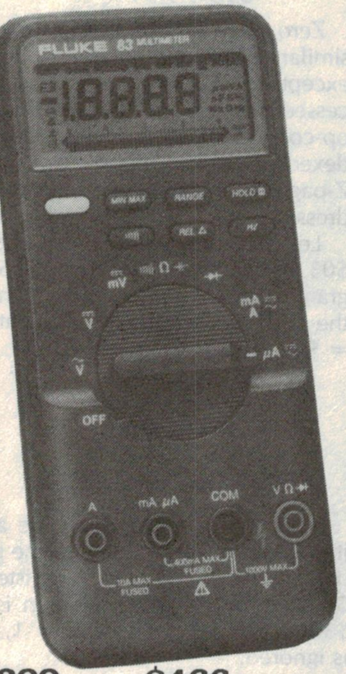

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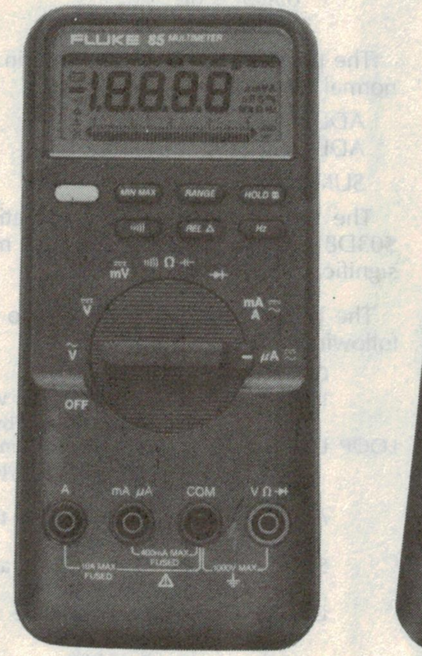

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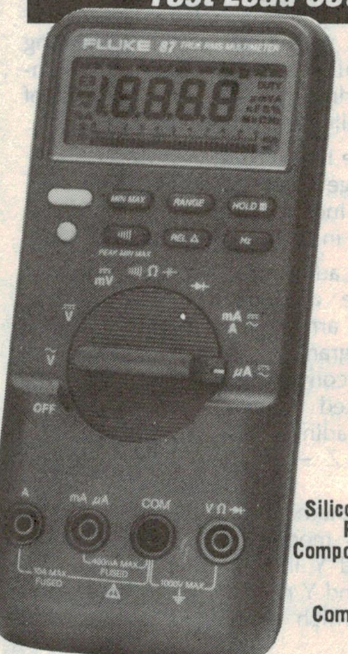

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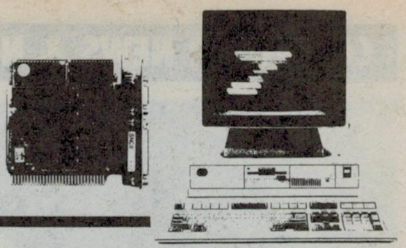
Computer News and New Products



Hand held printers

The new 1000 series available from Datacos comprises two compact (180mm deep by 115mm wide) impact dot matrix printers for applications which require a portable, hand held unit.

The boxed units incorporate a rechargeable battery capable of one hour's continuous print, with mains adaptor available as an option. The two models range from 24 to 40 column print, at speeds of up to 1.7 lines per second.

Paper and ribbon cassettes can be changed easily. Interface parameters are set externally without the need for DIP switches.

Communications for the 1000 series, are via standard RS232C and Centronics parallel interfaces with special interfaces available to suit individual applications. Print mode selections include normal, double height, double width, inverted and graphics from the international character set. Integral self test and fast paper feed complete the features.

For further information circle 170 on reader services coupon or contact Datacos, 10 Help Street, Chatswood 2067; phone (02) 410 9830.

$6 million H-K order for AST

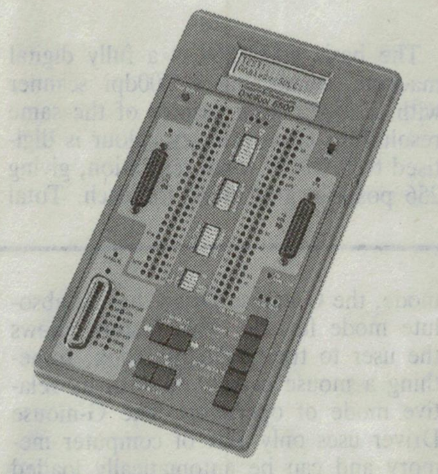
The Hong Kong government, in its largest single order of personal computers, has selected AST Research Inc to install more than 1500 386-based systems.

The purchase, valued at $6 million, marks the third consecutive time since 1987 that the government has selected AST for its office automation needs. The two year contract will be handled through Swire Systems, AST's Hong Kong dealer.

Under the terms of the agreement, the government will purchase AST Premium 386SX/16 and Premium 386/25 computers. The systems are for the Royal Hong Kong Police Force, Immigration Department, Trade Department and Information Technology Services Department.

The decision to select AST's systems was based in part on AST's patent-pending Cupid-32 architecture, which allows systems to be upgraded to higher-performing microprocessors with the simple exchange of a plug-in processor card.

For further information circle 161 on reader services coupon, or contact AST Research, 5/706 Mowbray Road, Lane Cove 2066; phone (02) 418 7444.



Multi-function communications tester

Datacom Technologies of USA has made a number of improvements to the Datatool 5000 communications tester, and released the result as the model 5500.

The most significant of the new features is dual line trapping, which allows both the transmit and receive data lines to be monitored simultaneously. A 4K trap buffer can be equally allocated to each data line, or assigned fully to either line. Other new features are analysis of SDLC communications, an expanded user message buffer, and detection of power dropouts during BERT testing.

Standard features of both instruments include pin analysis, device analysis, data throughput testing, flow control testing, BERT, bias distortion, cable testing, and a full 25 line breakout box. The instruments also allow storage of up to 16 user programmed messages, and provide for rotating ASCII patterns for transmission out of either of the two DB25 RS-232-C compatible serial, or the one Centronics parallel interfaces.

For further information circle 171 on reader services coupon or contact Elmeaso Instruments office on (02) 736 2888.

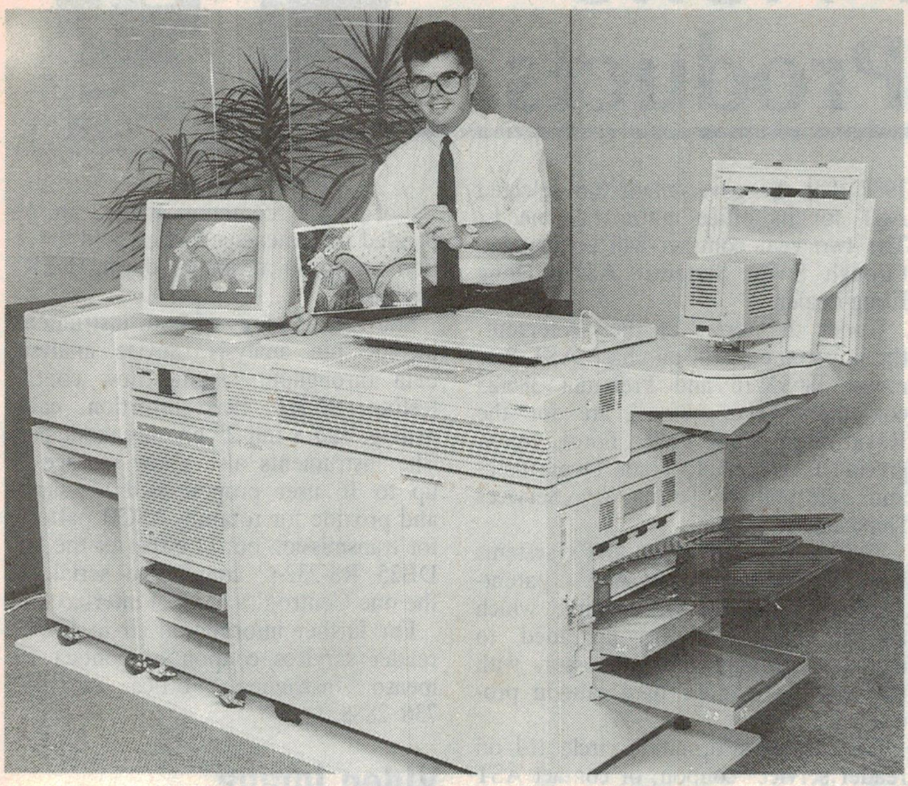
Video image capture using PC

Comda, a Brisbane based technical and commercial software company has developed and released Vice, a product designed to control all aspects of video image capture, manipulation and editing in the PC environment. Vice (Video Image Capture and Editing) is believed to be the first such product of its type developed and manufactured in Australia, and is said to be an example of the direction image production is taking.

Vice runs under MS-DOS on an IBM compatible 286 or 386 computer, with the Vice image grabbing card and software installed. The image grabbing card enables images to be captured and displayed in 32,768 simultaneous colours at a resolution of 512 x 512 from a standard video or still frame camera, or direct from a video recorder. Vice will also accept images from high quality colour scanners in the same number of colours and at much higher resolutions.

Vice has been designed to cater for a wide range of applications including image analysis, presentation graphics, desktop publishing and educational applications, at a cost within the budget of the average PC user.

For further information circle 173 on reader services coupon or contact Comda, 55 Anderson Street, Fortitude Valley 4006; phone (07) 252 2011.



Canon releases colour laser copier with computer interfaces

Canon's new CLC 500 colour laser copier is more than just a colour photocopier. In fact Canon describes it as a 'colour imaging system', because of its greatly enhanced flexibility and connectivity.

The basic CLC 500 is a fully digital machine, combining a 400dpi scanner with a colour laser printer of the same resolution. Each primary colour is digitised to 8 bits of tonal resolution, giving 256 possible gradations for each. Total scanning/printing time of an initial copy is around 20 seconds, with further copies at the rate of five per minute.

However the big feature of the CLC 500 is its ability to accept image information from other sources, to act as a colour laser printer. An optional film scanner allows production of A4 or A3 colour copies from 35mm transparencies, while an optional 'intelligent processing unit' (IPU) allows manipulation of images from either of the scanners or the IPU memory, before printing.

The IPU can also accept still video image files, or normal PAL video images. It also provides a bidirectional computer interface, allowing images to be fed from the CLC 500's scanner to a CAD or DTP system, as well as images to be fed from these systems to the CLC 500's printer.

A separate optional PostScript interface unit (PS-IPU) allows the CLC 500 to accept image files in the PostScript page description language, converting it into a high-resolution PostScript colour printer.

At the Australian launch of the CLC 500 in Sydney, Canon demonstrated the operation and capabilities of the unit both as a free-standing colour copier, as a still video printer and as a colour printer with DTP systems. Local software developer Digital Ideas also demonstrated its 'DICE' PC, PostScript and networking interfaces for the CLC 500.

For further information circle 175 on the Reader Service Coupon, or contact Canon Australia, 1 Thomas Holt Drive, North Ryde 2113; phone (02) 887 0166.

Mouse driver for digitiser

An upgraded version of the GTCO Sketchmaster tablet now includes a G-mouse driver, saving the user the cost of buying a mouse and the trouble of switching back and forth between the two devices. Using the Sketchmaster tablet with the mouse driver gives the user 1000 points per inch resolution (5 times greater than the average mouse).

In addition to standard relative mouse mode, the G-mouse Driver has an absolute mode feature. This feature allows the user to trace with precision, something a mouse cannot do with its relative mode of operation. The G-mouse Driver uses only 12K of computer memory and can be automatically loaded when the computer is powered up.

For further information circle 169 on reader services coupon or contact TCG Systems Automation, 30 Balfour Street, Chippendale 2008; phone (02) 699 8300.

14″ colour LCD PC

Sharp Corporation has released what is claimed to be the first 14″ colour LCD portable computer on the Australian market.

The PC-8081 features a Double Super Twist liquid crystal display with hot cathode fluorescent tube backlighting and VGA resolution. It also has a 32-bit 80386 CPU running at 20MHz, and includes a very fast 80MB hard disk drive with an average access time of 19 milliseconds.

The screen's VGA resolution allows 16 out of 512 colours with 640 x 480 dot display or 256 of 512 colours with 640 x 400 dot display. It is also ergonomically designed with 'soft' colours and a non-glare surface.

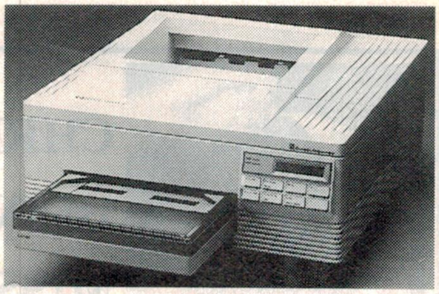
The PC-8081 has a full size detachable keyboard and incorporates two IBM standard 16-bit expansion slots. Additionally, the machine incorporates six external ports for maximum expandability.

For further information circle 163 on reader services coupon or contact Sharp Corporation of Australia, 1 Huntingwood Drive, Huntingwood, Blacktown 2148; phone (02) 831 9111.

Third generation laser from HP

Hewlett-Packard's third-generation Laserjet III offers improved print quality from HP Resolution Enhancement technology, on the fly font scaling and faster graphics printing.

The eight-page-per-minute Laserjet III printer uses the HP PCL 5 printer language and is compatible with and replaces the Laserjet II. It produces text and graphics with smoother edges,



sharper points and cleaner line intersection. This is accomplished through an HP-developed technology called HP Resolution Enhancement that adjusts the position and size of dots. These adjustments smoothe the stair-step effect inherent in 300 dots-per-inch printing.

The Laserjet III printer is the first implementation of the HP PCL 5 printer language. HP PCL 5 gives users compatibility with existing HP Laserjet printers and provides new features that customers have said they want most: more fonts in more sizes; increased page-layout flexibility; and faster graphics printing.

HP PCL 5 incorporates Intellifont font scaling, allowing the HP Laserjet III to scale its eight internal typefaces, as well as disk and cartridge based scalable typefaces, from 0.25 point to

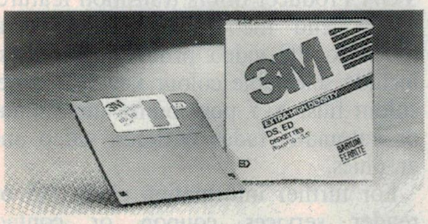
 READER INFO No. 39

999.75 points in 0.25 point increments.

The two font-cartridge slots on the printer lets users plug in existing HP font cartridges, the new scalable typeface cartridges, or a personality cartridge. An Epson FX/IBM Proprinter emulation cartridge and an Adobe PostScript printer-language cartridge are available.

The printer comes standard with 1MB of memory. Two slots for memory upgrade boards allows users to add up to 4Mbytes of printer with combinations of 1 and 2Mbyte memory boards.

For further information circle 172 on reader services coupon or contact Hewlett-Packard on toll free (008) 033 821.



4MB 3.5″ diskettes

3M Australia has released a high-capacity four megabyte 3.5″ diskette.

The new 'Extra High Density' (ED) diskettes are based on a new media formulation called barium ferrite, that 3M says will serve as the platform for a new generation of high capacity diskette products – which could eventually go up to 100 megabytes in a 3.5″ design.

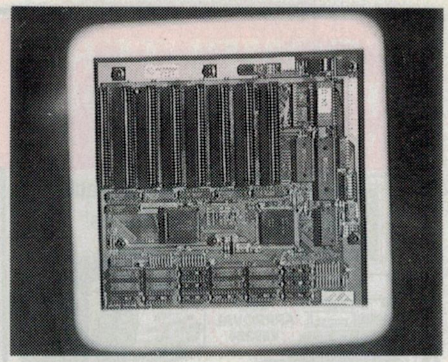
3M is working with leading hardware manufacturers in the development of compatible disk drives for the new 4MB ED diskettes and any future releases. Such drives are already available overseas and are expected to be released on the Australian market before the year's end.

For further information circle 167 on reader services coupon or contact 3M Australia, 950 Pacific Highway, Pymble 2073; phone toll free 008-022 293.

Low cost XT upgrade

Queensland computer manufacturer, Western Computer has released a low cost XT-286 motherboard suitable for IBM-compatible PC and PC/XT computers. The half size motherboard has an Intel 80286 286-10 CPU chip and the traditional eight expansion slots (all 8-bit) to provide an increase in performance, and will be used as one of the base platforms for Western Computer's slimline workstations.

The XT-286 motherboard is available as an upgrade product for those users wishing to increase the power of their



XTs, and will also be available from Western as a complete microcomputer with a 360KB 5.25″ and a 720KB 3.5″ floppy diskette drive, 640KB or 1024KB of memory, 101-key extended AT style keyboard, optional hard disk drives and controllers, LAN cards and video graphics adaptors and monitors.

Performance details include: Norton SI (Version 4.0) Computer Index relative to an IBM/XT of 10.9, a Landmark CPU test equivalent to an IBM AT running at 12.3MHz and a Landmark performance of 6.5 times relative to an IBM/XT.

For further information circle 166 on reader services coupon or contact Western Computer, 139 Sandgate Road, Albion 4010; phone (07) 262 3122.

JX-100 Scanner

Continued from page 147

nicely made, easy to use and produces good quality 200dpi image files in both colour and monochrome.

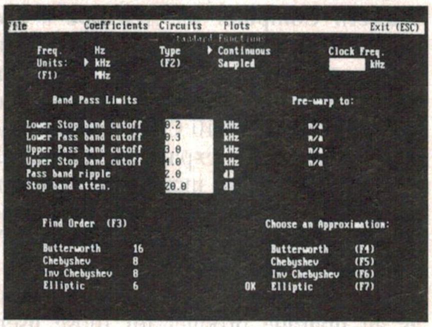
Quoted retail price for the JX-100 package for IBM compatibles is $2390, including *Windows 2.0* and a Microsoft mouse. The equivalent Mac and Amiga versions are only $1995, but of course don't include the software support platform.

For further information on the JX-100 circle 201 on the Reader Service Coupon, or contact Sharp Corporation of Australia, 1 Huntingwood Drive, Blacktown 2148; phone (02) 831 9111. Our thanks to Sharp for the opportunity to try out the sample unit.

Filter designer for PSpice

Filter Designer, a member of the PSpice family, is an interactive design aid giving the ability to design and analyse active filters. Features include a menu-driven interface, hard copy report summaries and plots, concatenation of multiple designs, and interfaces to PSpice and Switcap.

Filter Designer uses a well established methodology in applying classical approximations to your filter specification. Available filter types include low pass, high pass, band pass and band reject, all of which may be synthesised by Butterworth, Chebyshev, Inverse Chebyshev, and Elliptic (Cauer) functions. Both Bode and Pole Zero plots are available.



A full editing capability allows you to insert, delete, and reorder stages, and modify coefficient values. Filter Designer supports both active RC and switched-capacitor biquad filter structures. The components may be scaled or resized to centre the values in preferred ranges.

For further information circle 168 on reader services coupon or contact Technical Imports Australia, 220 Pacific Highway, Crows Nest 2065; phone (02) 954 0248.

Video from VGA graphics

VGA Producer, introduced by Magni Systems, is a single plug-in board for IBM AT's and compatibles which allows the user's VGA graphics to be converted to a professional level video signal.

VGA Producer uses a scan conversion process to encode VGA graphics to a stable, professional quality video signal in either PAL or Super VHS. Using the remote control box provided, this encoded signal may be mixed with another video source, recorded or live. Automatic or manual fades, keying on a selected colour, and X-Y image positioning on the screen are some of the available features.

The PAL version of VGA Producer will encode VGA graphics of pixel resolutions as high as 800 x 600 at 256 colours, as well as lower resolutions and EGA/CGA modes, to video which meets all the specifications for a PAL broadcast signal. Since VGA Producer operates in conjunction with a system's existing VGA card, software compatibility is not an issue: all software programs, be they video-specific or off-the-shelf business programs, may be converted to video with VGA Producer.

A remote control unit supplied with VGA Producer offers transition features which lend the finishing professional touch to PC video productions. These include selectable colour keying, border colour fills, X-Y positioning and manual or automatic fades between video and graphics.

For further information circle 165 on reader services coupon or contact Quinto Communications, 260 Auburn Road, Hawthorn 3122; phone (03) 819 6675.

Autodesk wins big defence contract

Autodesk has won a hotly contested site licence contract for 1500 AutoCad user licences with the Defence Science & Technology Organisation (DSTO). The agreement which is for an initial period of three years, represents the biggest of its type ever negotiated in Australia.

AutoCad, the world leader in PC based CAD software has been selected by the DSTO as a standard for its PC and workstation based computer-aided design (CAD) systems.

AutoCad was chosen over a number of other CAD systems because it represented the best value-for-money solution, said Vincent Scaffidi, Head of the Computer-Aided Engineering Group with the DSTO. "It is essential that we protect our investments in CAD generated data and information throughout the organisation."

"By using AutoCad where appropriate, we can simplify the process of data and information management and exchange between diverse and widely scattered user groups working in vastly different application areas and using various hardware platforms."

For further information circle 162 on reader services coupon or contact Autodesk Australia, 9 Clifton Street, Richmond 3121: phone (03) 429 9888.

Computers & electronics: Hooking things up

In this second of his short series of articles on using low-cost 'obsolete' personal computers in electronics, the author looks at ways of connecting them to other equipment.

by TOM MOFFAT

Computers – what are they good for? A rich man's toy? Well, maybe not so rich nowadays; computers are now really quite cheap. But once you get past the flashy games, what can you use computers for, in the *real* world?

In the first of these articles we looked at how small and nominally obsolete (read 'cheap') computers can earn their keep doing things like writing letters for you, or keeping accounts for a small business, or storing information for easy retrieval. Now let's get into the fun stuff, integrating small computers into your electronics projects.

This will not be a construction project as such, since every problem to be solved is different and every computer goes about it in different ways. So we will only toss around a few ideas, and suggest a few kinds of computer that might be handy for electronics experimentation.

In computer jargon, hooking a computer up to some outside device is known as input/output. Any electronic device, in order to do anything useful at all, must have input/output as well.

Back in my days with NASA, there were special terms to refer to these useful connections. If you thought of an electronic gadget as a 'black box', the place where you fed signals into it was known as the 'Guzzinta'. And the place where the results came out the other end was called the 'Cumzouta'. Perhaps these terms were used tongue-in-cheek, but I have actually seen professionally drafted circuit diagrams for quite sophisticated instruments, with sections carefully labelled 'Guzzinta' and 'Cumzouta'. Perhaps such frivolity makes life more bearable, when you're stationed on some horrid place like Johnston Island.

There you go, you've learned two new words today. But I don't think we'll use them any more in this article; they're too hard to spell. However you might want them handy so you can point some connector on the back of your friend's computer and impress him with "That's the Cumzouta!"

Input & output

Just about every small computer ever made has some form of input/output, although it might not be too useful for electronics experimentation. A printer port is just about universal, since a computer that can write letters and other documents is pretty useless if it can't type the finished letter on paper.

Printer ports can be one of two types – serial or parallel. Each character sent to the printer is represented by seven or eight data bits, and in the *serial* system the bits are sent quickly down one line, one after another in single file. There will be a 'start bit' at the start of the character, and a 'stop bit' at the end, so the printer knows when one character is finished and another begins.

In the *parallel* system, there are eight wires connecting the computer with the printer, so a parallel printer cable (as in an IBM-PC) will be quite portly, with rather large connectors on each end. All seven or eight data bits of a printer character are sent simultaneously, and there is another wire which is used to tell the printer that a character is on the other eight wires, ready for printing. A further wire runs from the printer back to the computer. The printer uses this to tell the computer that it has dealt with the current character and is ready for another. These last two wires are known as 'handshaking lines'.

So what we have in a parallel port is nine wires going out of a computer, and one coming back in. There may be other optional connections which can do things like tell the computer that the printer has run out of paper. The point of all of this is that you can forget all about the printer and use these wires for your own purposes. You can usually get at them by writing data to some computer address (either in 'memory space' or 'I/O space'), or by reading from another address.

A proper 'Centronics' type parallel port will be represented within the computer as a memory address capable of receiving an 8-bit data word or *byte*. Any bit that is a '1' in the byte sent to the address will result in the corresponding line being turned 'ON'. Similarly any bit that is a '0' will result in the line being turned off. The lines (the wires coming out of the connector) usually work at standard 'TTL' levels, so that one that is turned on will produce about +5 volts, and one that is turned off will be near ground level.

The two handshaking lines and some of the optional extras will also use TTL levels, and they will usually be accessed via something that is called a *status* or *control* port. The addresses of these ports will be different for every computer, but any programmer's reference manual for your machine will reveal what you need to know.

What can you do with an 8-bit output port? The answer to that question is just about anything your imagination can cook up.

For example, I was involved in a project to design a computer-driven weaving loom. A loom produces pretty patterns by moving various wooden bars called 'shafts' up and down, in some predetermined order. This is usually accom-

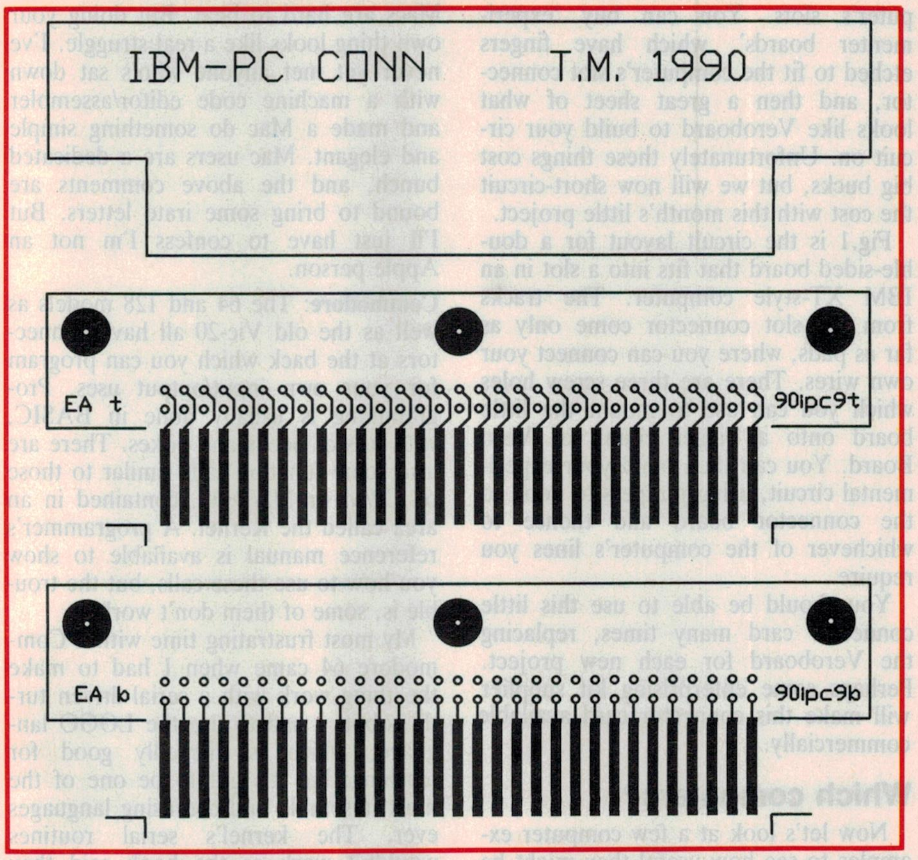


Fig.1: The author's actual-size patterns for an adaptor PCB to plug into an IBM compatible PC. From the top: overlay, top and bottom layers.

plished by the weaver doing a little dance on an array of foot pedals connected to the various shafts. We used a standard printer port on an IBM-PC, connected so that each of the eight data bits switched a solenoid on and off, and each solenoid in turn controlled whether a particular shaft went up and down. This was particularly convenient, since the loom in question had eight shafts.

Another application at a plant nursery required that various water sprinklers be turned on and off at various times. But there were many more than just eight sprinklers. So we considered the 8-bit printer port to consist of two 4-bit ports, side by side. Each one could therefore specify a numeric value between 0 and 15, encoded in binary fashion – in other words, 16 different possibilities.

We then designed a matrix system within the 'black box' connected to the printer port, which read the number off the first half of the printer port, and then the second half, and multiplied them together. This gave 256 possible combinations from eight output lines (16 times 16). The last I heard, the nursery was using more than 100 electronically switched sprinklers out of the 256 possible.

Almost all printer ports are 'one way – outgoing only, with some notable exceptions. Some models of the Toshiba laptop computers have printer ports which you can turn around backwards with a simple software command, so that you can bring 8-bit data in as well as sending it out. I've been using this system for a lot of projects, including a weather facsimile receiver that connects to the Toshiba's printer port.

Serial ports

Since the data bits are sent one after another, a computer's serial port needs only one wire to send them in a particular direction (apart from an earth return!). Serial ports are always bidirectional, so there will be a second wire which can bring data back into the computer. There are also several control lines, like the handshaking lines in the parallel port above.

There is usually a large integrated circuit within the computer called a UART, or 'universal asynchronous receiver-transmitter'. The chip is connected to the outgoing and incoming data lines, known as TD and RD, via some buffers.

You can directly program the UART chip with various data speeds and formats, and it does the job of flipping the outgoing data line high and low, or building up an 8-bit byte from the gyrations of the incoming data line. Some smaller computers such as the old Microbee don't have a UART chip; instead they emulate its actions with special software routines that are stored within the operating system.

Some UARTS take direct control of the control lines, while others let you set them high or low yourself. In this case you can commandeer the control lines for your own purposes, even though they may physically run through the UART chip. Since the Microbee simulates the UART in software, you can take control of the incoming and outgoing data lines as well.

Remember that the parallel port uses TTL levels, +5V for 'logic high' and 0 volts 'logic low'. However the serial port almost always uses what's called the *RS-232* standard, with voltage levels of about –12V for 'high' and +12V for 'low'. Note that the sense of these levels is inverted, and the levels are symmetrical about zero.

This is a carryover from the old days of mechanical teleprinter machines, which used either 'neutral' or 'polar' transmission along wires which could run a couple of hundred kilometres or so. Neutral was used for shorter runs, but the signals could become distorted if affected by capacity between the line and ground. Polar could largely overcome this distortion on long runs, since the line transitions were symmetrical about ground and capacity affected the 'high' and 'low' states equally. The errors would then cancel each other out.

Teleprinter transmissions used +130V/0V for neutral working, and –130V/+130V for polar. Teleprinter people could learn about these voltages very quickly by grabbing hold of the wires, especially if the polarity was reversed every 20 milliseconds or so by incoming signals. Much of the work on teleprinter lines was done while they were 'hot', so getting a good belt was a frequent occupational hazard.

RS-232 signals generally have a fairly low source impedance (they can deliver significant current as well as voltage), so they can be used over quite long lines, up to several hundred metres. And the minimum connection needs only three wires – transmit, receive, and ground – so simple domestic telephone cable can be used to run them all over a building. Parallel signals, on the other hand, are limited to cables around four or five metres long.

Hooking things up

If you intend to control something like the nursery watering system mentioned above, a nice way to do it would be to include a UART chip within the external interface circuit. That way you could use a simple three-wire cable to connect it with the computer's serial port, and have the computer a long way from the interface. The UART chip within the interface would break the serial signals out into eight parallel lines, just as if the watering system had been connected to the computer's parallel port.

The 'slot'

Sometimes you need more than just a few control lines running between your external device and the computer.

An example is a computer weather facsimile system I developed a couple of years ago. The final product ended up with its own microprocessor, but the experimental version used a Microbee for the processor, connected to the fax machine's input/output circuits; a clock oscillator; and interrupt lines. So the gadget needed access to all the Microbee's data lines, several of its address lines, a read/write line, and several other circuits.

This was easy, because Microbees can have a connector fitted on the back which gives access to every important signal line in the computer. They don't come with the connector, just a space for it on the circuit board; you have to fit your own. But that's easy.

If a computer is designed to give the user access to its 'guts' in this way, it's said to have *open architecture*. This is usually implemented via several connectors wired more or less in parallel, installed within the computer's case, and generally called 'slots'. The Apple II series of computers were probably the first to do this, closely followed by the IBM's and all their clones.

You can buy plug-in cards for these computers for just about any purpose imaginable. There are many different video boards for the IBM, and there are serial and parallel port cards. You can also get a thing that pretends to be an office fax machine; you can fit a built-in modem, or you can install a card with about a zillion input/output lines, all by plugging into a slot.

All these things can exist at once until you run out of slots – or overload the computer's power supply with all of the extra circuitry.

You can, of course, build your own accessory to fit into one of your computer's slots. You can buy 'experimenter boards', which have fingers etched to fit the computer's slot connector, and then a great sheet of what looks like Veroboard to build your circuit on. Unfortunately these things cost big bucks, but we will now short-circuit the cost with this month's little project.

Fig.1 is the circuit layout for a double-sided board that fits into a slot in an IBM XT-style computer. The tracks from the slot connector come only as far as pads, where you can connect your own wires. There are three screw holes which you can use to mount the little board onto a bigger chunk of Vero Board. You can then build your experimental circuit, using jumpers to hook to the connector board and thence to whichever of the computer's lines you require.

You should be able to use this little connector card many times, replacing the Veroboard for each new project. Perhaps some enterprising kit supplier will make this connector card available commercially.

Which computers?

Now let's look at a few computer examples to see how useful they might be for experimental work. This is obviously not a complete list, but it represents machines I've actually used, connected to things like educational robots. To avoid offending anybody, the order is alphabetical.

Apple: The early Apple II series machines have several slots which you can get to simply by popping the cover off. There are (or were) lots of different commercial boards available for these slots, and of course you could make your own. Over the years I have designed both serial and parallel interfaces for Apple slots.

But beware: the usual UART chip used with the Apple is type 6551. These are VERY easy to blow up, so be careful. Never remove or install a card while the computer is running. This applies to any machine, not just Apples.

Personally, I never got along well with Apples. I found them stubborn and hard to program. You can spend hours, or days, trying to sort out some interfacing problem, only to find out the computer itself isn't sending data to where you think it should go.

The newer Apple MacIntosh is a 'closed' system; hooking up your own gadgets isn't really encouraged. The machine is said to be very easy for a beginner to operate with all its little graphics and its 'point and shoot' mouse.

Running ready-made applications, Macs are hard to beat. But doing your own thing looks like a real struggle. I've never yet met anyone who's sat down with a machine code editor/assembler and made a Mac do something simple and elegant. Mac users are a dedicated bunch, and the above comments are bound to bring some irate letters. But I'll just have to confess I'm not an Apple person.

Commodore: The 64 and 128 models as well as the old Vic-20 all have connectors at the back which you can program for your own input/output uses. Programming is usually done in BASIC, with lots of peeks and pokes. There are also some function calls similar to those of CP/M or MS/DOS, contained in an area called the Kernel. A programmer's reference manual is available to show you how to use these calls, but the trouble is, some of them don't work.

My most frustrating time with a Commodore 64 came when I had to make the thing work with a serial-driven turtle robot. I had to use the LOGO language, which is allegedly good for teaching; but it's got to be one of the most miserable and confusing languages ever. The kernel's serial routines wouldn't work as the book said they would, so I had to write my own in machine code and then make them work with LOGO. Ugh!

Somebody must have had success with Commodores, because there are lots of amateur radio applications written for them – including a packet radio program that doesn't need an external 'terminal node controller'; the C-64 does the lot itself. Commodores are also particularly good for radio work, because they don't radiate much RF noise.

CP/M machines: The CP/M operating system standard covers many different computer systems. The earliest used a thing called an S-100 bus, which was a slot system similar to Apple's and IBM's. Later, more business-oriented machines did away with the slots but still kept useful serial and parallel ports. Nowadays CP/M machines are no longer trendy, so you can pick them up for a song. If one comes your way, swallow your pride and grab it!

CP/M programming is very straightforward (if you're familiar with MS-DOS, you'll find it easy, because this was partly modelled on CP/M). There are several function calls which you can get at via Z-80 machine code, to do things like send a character to the screen or get an input from the keyboard or from the serial port. You simply put a character in a register, put the function number in another register,

and call a subroutine at location 5. Presto! Character on screen. Basic, Turbo Pascal, C, and many other languages are available in CP/M and nowadays are very cheap. Professional results can be yours for peanuts.

Microbee: These come as either CP/M machines, or as cassette-based ROM machines. The ROM-based 'Bees are a bit past it now, but are still very useful for experimenting. They have BASIC built in, and you can get a machine-code editor/assembler in a ROM. The 'Bees have lots of yummy in-out capabilities, including the connector on the back with every address, data, and control line on it.

Original Australian-made 'Bees are selling really cheaply now, and it's even said to be possible to get one for nothing if you get down on the floor and grovel enough. The maker, Microbee Systems, went through a series of financial crises, and factory support for them is a bit shaky now. But they don't use all that many special parts, so you can fix them yourself quite easily. All the technical information you need is freely available.

MS-DOS machines: MS-DOS is the common operating system found in IBM computers and their clones. As noted above it was modelled on CP/M, and works in much the same way. The 'function call' technique is similar, except that there are very many more of them. As mentioned previously, these computers have wide-open architecture, and what you can do with them is only limited by your skill and imagination.

The general MS-DOS family of machines grows ever fatter and more complicated all the time, but this means that earlier models quickly become obsolete. This is great, because the early ones are the most docile and best for experimenting.

It is even possible to build up your own MS-DOS computer from scrapped components and circuit boards. I have seen these home-brew marvels with bits of wires hanging everywhere, scruffy old cases drilled full of holes, and keyboards from elderly word processors. They look, in fact, much like the amateur radio gear of past years, re-cycled from dud commercial gear or built from scratch. Is amateur computing becoming the new amateur radio? There you are, have a nice open can of worms...

In the third of these articles we'll finally look at laptop computers, those handy little tools that seem to be moving into every interesting area of computing.

Basics of Microprocessors

Continued from page 149

```
00E0: 56---------------
      (low order byte of
      address)
00E1: 02---------------
      (high order byte of
      address)
```

The memory location $E0 has been labelled LOC. We assume that location $E0 and $E1 are loaded with $56 and $02 respectively. These locations are both in page zero.

In line 2 the Y-register is loaded with the required index – $33. When line 3 is executed, the MPU reads the contents of $00E0, which contains the low order byte of the base address. It now automatically goes to the next address location after $00E0, namely $00E1, and reads its contents. This is the high order byte of the base address – $02. The base address is $0256. The complete address of the operand, i.e., the address from which the accumulator is loaded in line 3, is determined by adding the contents of the Y-register onto $0256. This gives $0289.

The accumulator is loaded with the contents of address location $0289. If a carry were generated when the index was added onto the low order byte, it would have been carried over into the high order byte.

This addressing mode is called post indexed addressing since the index is added after the base address if formed.

Post indexed addressing has more flexibility than indexed addressing. Unlike indexed addressing it specifies only the address in page zero that contains the base address. This is very useful in dealing with a table or an array. All that is required is to place the starting address in the appropriate locations in page zero. The starting address requires two bytes with the low order byte being placed first.

Post indexed addressing unfortunately, requires a great deal of computer time: six cycles compared with the four required for zero page indexed addressing. In spite of this minor drawback, the additional flexibility available is excellent. Entire arrays need not be moved nor are repeated versions of the same program required.

Index Indirect Addressing is similar to Indirect Indexed Addressing except for a few minor differences. Let us examine the program segment shown below to understand this addressing mode:

```
LOC     EQU     $02
        LDX     #$24
        LDA     (LOC, X)
        "
        "
        "
0026    :       EE
0027    :       B0
```

The low order byte of the address of the operand is found by adding $24, the contents of the X-register, to $02 (LOC) to give $0026. Address location $0026 contains $EE. This is the low order byte of the address of the operand. The high order byte is found at the next consecutive address, i.e., at $0027, which contains $B0. The address of the operand is $B0EE, and the accumulator is loaded from this address.

Unlike in post indexed addressing which we examined earlier, the addition of the contents of the X-register were carried out before the complete base address was determined. For this reason, indexed indirect addressing is also referred to pre-indexed addressing. •

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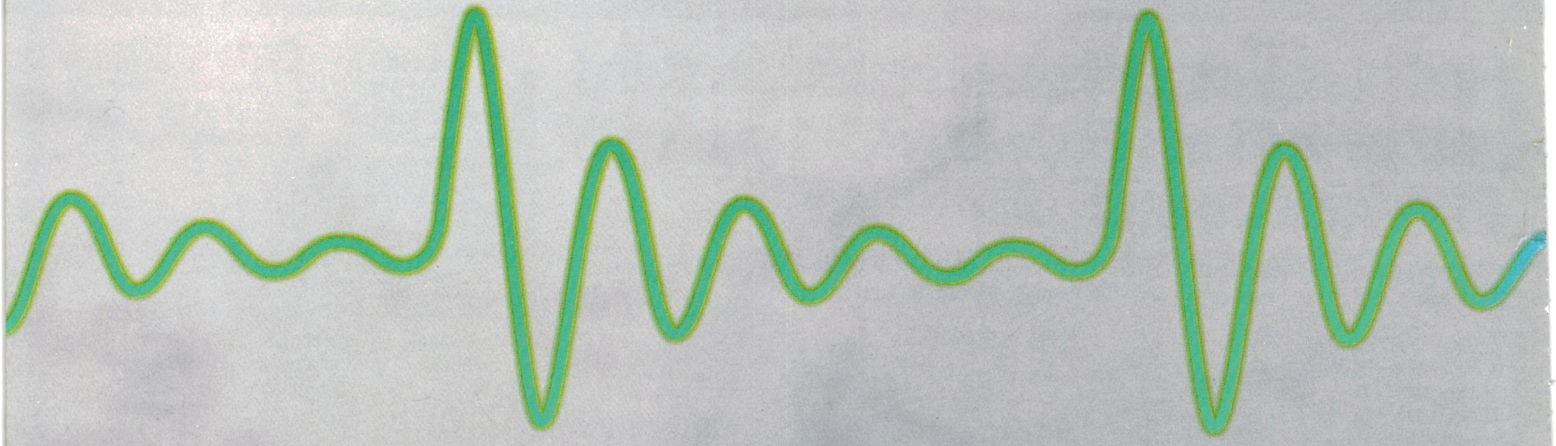
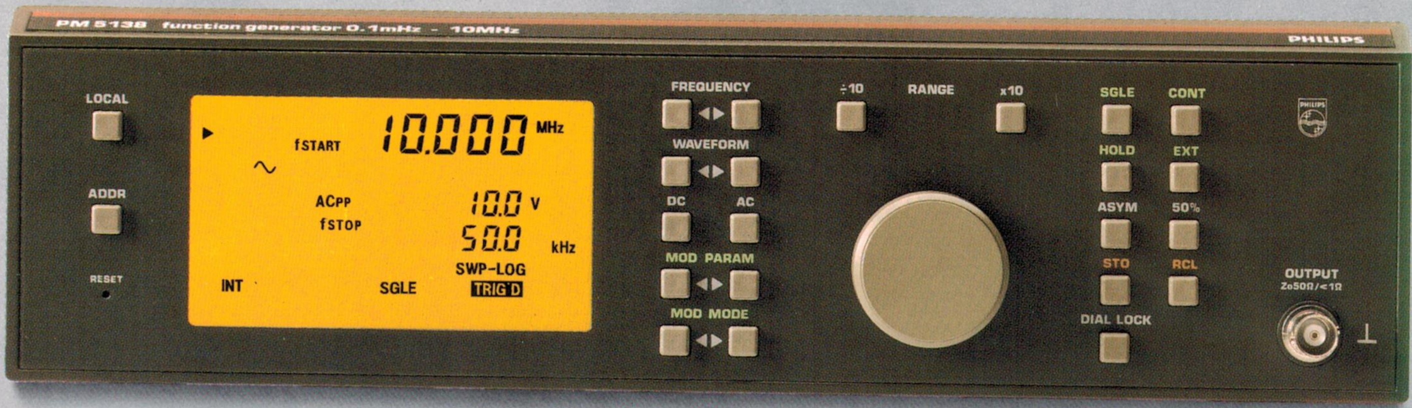
The generator that rules the waves!





Choose from standard or user-defined arbitrary functions

The new PM5138 function generator has performance that rules the waves from 0.1 mHz up to 10 MHz. Giving you fast, simple control of every waveform you want to generate. Not just on any of the 7 standard waveforms, but also with a user-defined arbitrary function. A wide choice of modulation modes is available for all functions – both standard and arbitrary.

Versatile waveform generation is just one way that the PM5138 makes your work simpler. Operation is menu-driven, controlled by just a few fingertip pushbuttons. There's just a single, large rotary control for precise setting of numeric values. And the clear, backlit LCD panel gives you an instant, at-a-glance readout of all parameter settings.

The arbitrary function can be captured from your test system by a digital storage oscilloscope, or mathematically defined on the PC. Either way, you can simply download it to the PM5138, and reproduce it at any time as a reference or test signal.

The PM5138 is just one of a full range of function, pulse and signal generators from Philips and Fluke – the global alliance in Test & Measurement.

For further information please contact your local Philips Test & Measurement Organisation:

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